MINING ENGINEERING

OCTOBER 1949

Incorporating
MINING and METALLURGY
MINING TECHNOLOGY
COAL TECHNOLOGY

MINING ENGINEERING

VOL. I NO. 10 OCTOBER 1949

In This Issue

COVER

What the control operator sees from his perch 125 ft above the loading platform for an inclined hoist from the pit to a stationary screening plant at the open pit South Agnew iron mine of the M. A. Hanna Co. near Hibbing, Minn. The operator has remote control of the hoist which is set 300 ft from the tower. The remote control gear, brake controls, and hoist were supplied by Allis-Chalmers Manufacturing Co.

Published by the Mining Branch, AIME to provide a continuing, authoritative, and up-to-date record of technologic, engineering, and economic progress. The American Institute of Mining and Metallurgical Engineers, 29 West 39th Street, New York 18, N. Y.

Published the first day of each month by the American Institute of Mining and Metallurgical Engineers, Inc., 29 West 39th Street, New York 18, N. Y. Telephone: Pennsylvania 6-9220. Subscription $8 per year for non-AIME members in United States and North, South and Central America; $9 Foreign; $6 for AIME members, or $4 in combination with a subscription to *Journal of Metals* or the *Journal of Petroleum Technology*. Single copies, 75 cents; special issues, $1.50 . . . The AIME is not responsible for any statement made or opinion expressed in its publications . . . Copyright 1949 by the American Institute of Mining and Metallurgical Engineers, Inc. . . . Registered cable address, AIME New York . . . Indexed in Engineering Index and Industrial Arts Index . . . Entered as second-class matter January 18, 1949, at the post office at New York, N. Y., under the act of March 3, 1879. Member, ABC.

AERO IS AT HOME . . . ANYWHERE!*

AERO mapping crews are at home abroad. For our men have flown Canada's muskeg and Alaska's arctic wastes—kept projects highballing in the tropics of South America and Africa. White Horse, Maracaibo, Durban, Lourenço Marques, Johannesburg, and many other remote points are familiar locales to AERO crews.

How does AERO's worldwide mapping experience pay off for you? First, AERO brings to your project the solid knowledge of its engineering technicians and explorers, specialists in all phases of aerial mapping. Important time and money are saved in planning your work. Then AERO crews go to work, *anywhere in the world*, with on-the-spot ability to get the job done *fast* and economically.

Our clients in the mining industry have found our 30 years' experience valuable, both in reconnaissance mapping and in detailed topographic mapping for later development work. Let us show you how economical aerial mapping can speed your project. Write AERO today.

**Interested Zulu audience at Durban looks at the airborne magnetometer used in aerial magnetic reconnaissance of several areas for large mining interests in the Union of South Africa, as well as for the Mozambique Gulf Oil Company's survey in Portuguese East Africa.*

AERO
SERVICE CORPORATION
236 E. COURTLAND ST., PHILA. 20, PA.
Oldest Flying Corporation in the World

AERIAL PHOTOGRAPHY • COLOR PHOTOGRAPHY • PRECISE AERIAL MOSAICS • AIRBORNE MAGNETOMETER SURVEYS • PLANIMETRIC MAPS • TOPOGRAPHIC MAPS • RELIEF MODELS

El-Tronics INC.

FINEST "IN THE FIELD!"

GEIGER MÜLLER

Portable

SURVEY INSTRUMENTS

URANIUM ORE

MODEL SM3

Here is the finest portable survey instrument made for tracking down elusive uranium ores. Of lightweight welded aluminum construction it weighs only 8¾ pounds, is completely waterproof and can be carried anywhere. A self-contained Geiger-Muller counter tube probe unit attached to the instrument by a 30" cable makes taking measurements in crevices and confined places an easy matter. Radiation intensities can be read in a few seconds directly from the indicating meter. Its three full scale ranges detect the most sensitive impulses, with instantaneous accuracy. Backed by 14 years of design experience, the SM3 is ideally suited to rugged use in the field without sacrificing any of the delicate sensitivity of laboratory equipment.

Outstanding Features:

- Battery life in excess of 200 hours
- No Tools necessary to replace batteries
- Instantaneous readings directly from scale of 3" meter
- Uses standard miniature type radio tubes
- Counter tube sensitive to both Beta and Gamma radiation
- Complete and ready for operation $225

WRITE FOR FREE ILLUSTRATED BROCHURE

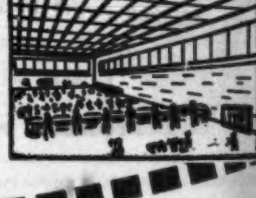
El-Tronics INC.

2647-67 N. HOWARD STREET
PHILA. 33, PA.

America's Foremost Crafters Of Scientific Equipment

A COMPLETELY EQUIPPED PRECISION ELECTRONICS PLANT TO SERVE YOU

El-Tronics offers unexcelled production facilities for the manufacture and assembly of precision electronic equipment of all kinds. Our plant offers excellent tooling, skilled engineering and highly trained craftsmen. Call on us for a discussion of your requirements.



JOY AXIVANE*

GIVE YOU TOP EFFICIENCY WITH ANY LENGTH OF TUBING

IF MAIN VENTILATION is your Problem

JOY AXIVANE* MINE FANS

GIVE YOU MORE AIR AT FAR LOWER COST

*Trade Mark Reg. U.S. Pat. Off.

Right: a twin installation of Type 1-21 JOY AXIVANE Blowers at a large metal mine.

BLOWERS

Below: the same twin units, looking down. Left, opposite page: a typical JOY AXIVANE Exhaust Mine Fan installation, at another metal mine.

JOY BLOWERS

are *All-Purpose* units

With the *vaneaxial* design, pioneered by JOY in mine ventilation equipment, you secure the great advantage of unmatched efficiency over the widest possible operating range. JOY AXIVANE Blowers give you top performance in either high or low pressure service. You don't need different types of blowers for different lengths of ventilation tubing, and you eliminate blower replacement when the tubing length must be changed. What's more, JOY Blowers are compact and space-saving, operate more quietly, provide smoother air flow and require minimum power. ● Let JOY solve your air supply problems . . . there are types and sizes of AXIVANE Blowers and Fans to meet every mine ventilation requirement.

Write for Bulletin, or *Consult a Joy Engineer*

W&D M 2340

JOY MANUFACTURING COMPANY

GENERAL OFFICES: HENRY W. OLIVER BUILDING · PITTSBURGH 22, PA.

IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LIMITED, GALT, ONTARIO

Advertisers' Index—

**Previous Issues.*

Azusa Rock & Sand Co. Cuts Costs with "*A-1*" Jaw Crusher

CALLED "ONE OF THE most efficient crushing plants in the country," Azusa Rock & Sand Co. of California installed this 42x32 in. "*A-1*" jaw crusher to break gravel boulders, some as large as 30 inches. Feed runs 100 to 200 TPH; sometimes as high as 250 TPH.

Heavy-going demands like this have been everyday routine, six days a week, for this Allis-Chalmers machine since 1946. Yet, the original main bearings are still going strong. Operation has been practically trouble-free. Only jaw plates and toggle bearings have been replaced.

MANPOWER ECONOMY

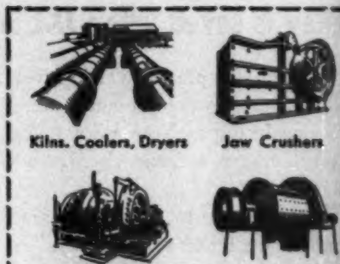
Convenient all-electric controls regulate feeder, crusher and belt conveyor to surge pile. All controls are sequence interlocked. Only one operator is needed.

CHECK THESE "A-1" FEATURES

- No choking or packing in the "*A-1*" jaw crusher — crushing is uniformly distributed throughout the entire depth of the crushing chamber.
- Jaw opening nips biggest pieces with minimum slippage.
- Renewable parts protect expensive castings from wear, greatly prolong crusher life.
- Automatic lubrication of main pitman and swing jaw bearings.

Find out more about "*A-1*" *jaw* crushers and other Allis-Chalmers crushers from the A-C representative in your area. Or write for Bulletin 07B6369A. Allis-Chalmers offices or distributors are in principal cities in the U.S.A. and throughout the world.

A-2817



AND OTHER EQUIPMENT FOR THE CRUSHING, CEMENT AND MINING INDUSTRIES

ALLIS-CHALMERS, 971A SO. 70 ST.
MILWAUKEE, WIS.

"*A-1*" is an Allis-Chalmers trademark.

ALLIS-CHALMERS

WICKWIRE ROPE
A PRODUCT OF
CF&I
Ask any user . . . you'll find them everywhere
In scores of industries, users of Wickwire Rope have developed an affectionate respect for its performance, safety and long life. And, for true economy, they use Wickwire's WISSCOLAY® Preformed. It lasts longer—is easier to cut, splice and install. It's kink-resistant and safer to handle. Wickwire Distributors and Rope Engineers, in key cities everywhere, are prepared to render prompt service in meeting your wire rope needs. Wickwire Rope Sales Office and Plant—Palmer, Mass.
IN THE EAST—Wickwire Spencer Steel Div. of C. F. & I.
500 Fifth Ave., New York 18, N. Y.
IN THE ROCKIES—The Colorado Fuel and Iron Corp.
Continental Oil Bldg., Denver, Colo.
ON THE WEST COAST—The California Wire Cloth Corp.
1080—19th Ave., Oakland 6, Cal.
LOGGING
TRANSPORTATION
MINING
PETROLEUM
MANUFACTURING
MARINE
CONSTRUCTION

Open-Pit Mining

Contractor with excellent equipment and experienced personnel interested in excavating or open-pit mining work.

Box G-21 — MINING ENGINEERING

MINE FOREMAN, college graduate, experienced metal miner, standard three-year contract, single status or if married single status for six months, working knowledge Spanish essential, starting base salary $4,800 yearly plus bonus one month yearly, free transportation to Bolivia by air for employee and wife, four weeks' vacation yearly, free living quarters.

Box H-22—MINING ENGINEERING

JUNIOR MINE ENGINEER, college graduate, competent underground surveyor, draftsman, standard three-year contract, knowledge Spanish desirable, starting base salary $2,700 yearly plus bonus one month yearly, single, free transportation to Bolivia by air, four weeks' vacation yearly, free living quarters.

Box H-23—MINING ENGINEERING

Personnel

Engineering Societies Personnel Service, Inc.

New York—8 West 40th St.
Detroit—100 Farnsworth Ave.
San Francisco—57 Post St.
Chicago—84 E. Randolph St.

In applying for positions advertised by the service, the applicant agrees, if actually placed in a position through the service as a result of these advertisements, to pay a placement fee, established to maintain an efficient, non-profit service.

All replies should be addressed to the key numbers indicated and mailed to the New York office. Include six cents in stamps for forwarding application to the employer and for returning when necessary.

A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3.50 per quarter or $12 per annum, payable in advance.

Positions Open

Mining Engineers. (c) Junior Mine Engineer, graduate, competent mine surveyor-draftsman; single status; three-year contract. Starting salary, $2700 a year plus bonus. Knowledge of Spanish desirable. Transportation paid. (d) Mine Foreman, graduate, experienced in metal mining; single status six months. Three-year contract; $4800 a year, plus bonus. Working knowledge of Spanish essential. Transportation paid to Bolivia by air for employee and wife. Four weeks vacation a year. Free living quarters. Y-988.

Engineers: (a) Mine Electrician $4800 a year. (b) Mine Mechanical Superintendent. $5400 a year. Must have knowledge of Spanish. Three-year standard contracts. Location, Bolivia. Y-2683.

Mill Superintendent, 30-35, at least five years' milling supervisory experience, to take charge of flotation plant handling copper concentrates. $4800-$5400 a year, plus living quarters. Three-year contract. Location, Peru; 11,000 ft. elevation. Y-2707.

Engineers. (b) Assistant Mill superintendent, preferably graduate, with eight years' experience in large milling plant. Good knowledge of general, preferably of heavy sulphide, flotation. (c) Mill foreman, technical or practical mill man, with considerable supervisory experience in flotation practices, general mill operation and maintenance. (d) Mine master mechanic. Wide experience in blacksmithing practices and all metal mine equipment including air drills, bits, detachable and conventional, compressors, ventilators, car loaders, piping, track and cars, hoists, slushers, and general mine work. Furnished house and utilities provided. Three-year contracts. Traveling expenses paid. Location, Mediterranean area. Y-2709.

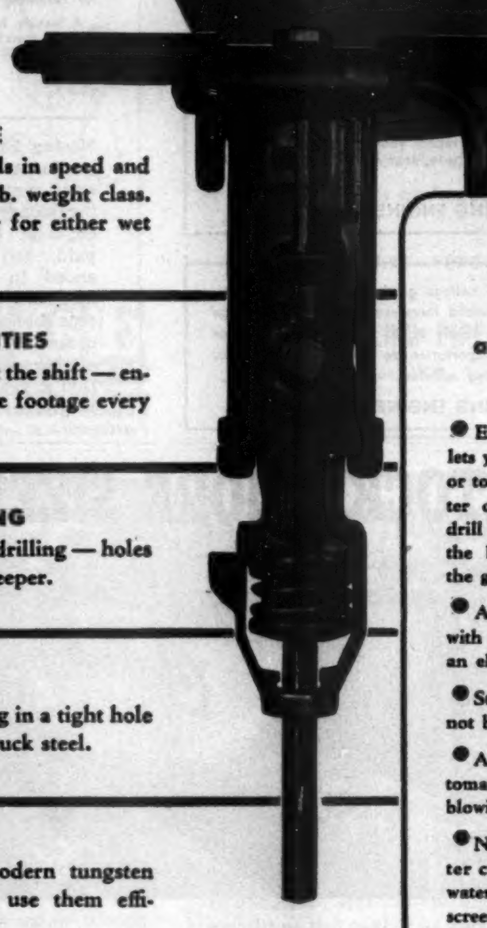
Continued on p. 25

new!

GARDNER-DENVER

S48 Sinker

... no other Sinker gives you all these advantages!



SUPERIOR DRILLING PERFORMANCE
— equals most 55-pound drills in speed and power — yet is in the 45-lb. weight class. An outstanding performer for either wet or dry drilling.

SUPERIOR RIDING QUALITIES
— easier handling throughout the shift — enables operator to drill more footage every day.

SUPERIOR HOLE CLEANING
— better hole-cleaning while drilling — holes are bottomed faster and deeper.

SUPERIOR ROTATION
— extra fight keeps bit turning in a tight hole — reduces possibility of stuck steel.

SUPERIOR DESIGN
— especially suitable for modern tungsten carbide bits — helps you use them efficiently.

SUPERIOR CONSTRUCTION
— rugged, dependable, simple — fewer trips to the shop.

No other Sinker has all these advanced features

- Exclusive backhead design — lets you change from wet to dry or to automatic air-operated water control without taking the drill apart — without changing the backhead. Simply change the gland and tube.
- Air or water tube comes out with the gland — no fishing for an elusive tube.
- Straight throttle valve — will not bind or leak.
- Air-cleaning screen that automatically cleans itself when blowing.
- New-type, free swiveling water connection — has positive water seal and large area tubular screen.
- Exclusive steel puller — swings clear of the chuck — easily operated by foot or hand — easily assembled without wrenches — no nuts to keep tight.
- Write today for full information on the NEW Gardner-Denver S48 Sinker.

GARDNER-DENVER

Since 1859

Gardner-Denver Company, Quincy, Illinois
In Canada:
Gardner-Denver Company (Canada) Ltd., Toronto, Ontario

Personnel

(*Continued from p. 23*)

Mechanical Engineer, graduate, for central engineering staff of large company, who has had some experience on maintenance and mechanical problems of mining equipment, to make investigations and reports. Should have an interest in solving diversified problems. Some thermodynamics or heat transfer experience desirable. Will consider a mining engineer who is familiar with mechanical problems. Some traveling but over one half of time will be spent in headquarters in Chicago, Illinois. Salary open. Y-2773.

Assayer with foreign experience, for gold project of large company in Latin America. Ability to speak Spanish highly desirable. Salary open. Y-2786.

Mining Engineer, single preferred. Hard rock and placer experience for exploration project in British Guiana. $4800-$5400 a year, plus expenses. Y-2804.

Engineers. (a) Assistant to the manager, 28-30, preferably married, with at least four years' experience in low coal mining. Position includes mine surveying work, occasional supervi-

(*Continued on p. 31*)

Equipment News

New Coal Cutter Bit. A new type of heavy duty carbide tipped coal cutter bit developed through field tests on numerous designs of cemented carbide tipped bits has been announced by Carboloy Co., Inc., Detroit, Mich. Experiences with carbides in the cutting of metals and non-metallic parts on machine tools were of little use in the designing of coal cutting bits. As a result, the carbide tipped coal cutting bit has undergone considerable evolution since its introduction in coal mining in the United States.

34-Ton Tandem Axle Euclid. Having successfully completed thorough field tests on the Minnesota Iron Range, the new Model FFD rear-dump Euclid was recently announced to distributors. This new model is powered by two diesel engines—mounted side by side—of 190 hp. each. There is no clutch pedal or manual shifting of gears—the operator can change to the proper gear under full power at any travel speed. Top speed with full 68,000 lb. payload is 25.5 m.p.h. . . . total braking surface is 1620 sq. in. The Euclid Road Machinery Co., Cleveland, Ohio, will be glad to send further information on this new model.

New Rubber Tire Loader. A new rubber tired type-28 FA face loader has been introduced by the Clarkson Mfg. Co. of Nashville, Ill., manufacturers of the well-known "Redbird" mechanical loaders. Designed to permit more versatile loading operation, the new rubber tired loader has many new construction and operational features for ease and efficiency of operation. One 50-hp. motor operates the entire unit, with push-button hydraulic controls conveniently located in one central unit. The front digging head has a maximum loading range of 130 in., and by swinging the head and the chassis at the same time, operators can reach the corners as well as work in and around closer face timbers. Offering a capacity of 10 tons per minute, this loader contains the Clarkson "Redbird" Uniflight Conveyor Chain, with the rear conveyor including a special conveyor break that enables the operator to move the discharge conveyor into almost any position to meet high- or low-mine roof conditions.

Copper-Fin, Totally Enclosed, Induction Motors. Type CS, totally-enclosed, fan-cooled, squirrel-cage motors with copper fins embedded in the stator laminations for additional cooling are announced by Westinghouse Electric Corp. These motors are suitable for application in central stations, cement mills, coal pulverizing plants, steel mills, and in other locations where the atmosphere is contaminated with dust particles that are injurious to an open motor.

Wet Grinding Mills. Bulletin AH-389 is a 16-page discussion of Hardinge wet grinding mills. It covers conical ball and pebble mills—with installation operating data and flow diagrams, convex-head cylindrical mills, "packaged" wet grinding systems, classifiers, thickeners, feeders, Ruggles-Cole rotary dryers, and the Hardinge "Electric Ear."

Authors in This Issue


A. L. Toenges

Albert L. Toenges (p. 361): Born in Dayton, Ohio, attended Steele High School and received his M.E. degree from the Colorado School of Mines in 1912. AIME member since 1915. He now lives in Pittsburgh, Pa., and is principal coal mining engineer for the fuels and explosives division, U. S. Bureau of Mines. He has presented three other papers before AIME meetings. . . . **Julian W. Feiss** (p. 50): Born in Cleveland, Ohio, he attended Princeton Univ., (A.B.); and the Arizona School of Mines (M.S.). He spent many years as a geologist in Africa, has served on the technical staff of Climax Molybdenum Co., was formerly editor of **Mining Congress Journal.** Now assistant to the director, U. S. Bureau of Mines. Lives in Falls Church, Va. Member of AIME since 1927. Enjoys big game hunting. . . . **S. H. Ash** (p. 349): Born in Roslyn, Wash., attended Bethlehem Prep., Bethlehem, Pa. B.S. in coal mining engineering, Lehigh Univ., and E.M. in mining engineering, Univ. of Washington. With Bureau of Mines since 1929, now chief of safety branch. AIME Member since 1915. Likes fishing, stamp collecting, bird watching and gardening. . . . **E. C. Houston** (p. 365): Born in Bessemer, Ala. Bessemer High School and B.E. degree from Vanderbilt Univ. With American Briquet Co. and U. S. Cast Iron Pipe and Foundry 1929-33. Since 1934 he has been a development engineer with the Tennessee Valley Authority. Lives in Sheffield, Ala., enjoys fishing. **C. O. Swanson** (p. 38): Born in Oshkosh, Wis., B.A. Sc., mining engineering, Univ. of British Columbia., Ph.D., geology, Univ. of Wisconsin, 1924. Ass't professor, Univ. Wisconsin, 1924-48; head, department of geology, Michigan College of Mining and Technology, 1928-36; professor of petrology, Univ. of B. C., 1936-46. Now chief geologist, Consolidated Min. & Smelt. Co. of Canada, Ltd. Dr. Swanson has published over a dozen technical papers in various professional journals. Lives in Trail, B. C. His chief recreation is golfing. **J. J. Forbes** (p. 349): Born in Shamokin, Pa., he attended State Normal School, took his B.S. in mining from Penn State College in 1911. Began working in mines at the age of ten, later taught public school, and joined the U.S.B.M. as a first-aid miner in 1915. Headed mineral production security divi-


S. H. Ash


T. L. Kesler


J. G. Evans


R. L. Powell

(Continued on P. 31)

Appraisals
Assayers
Chemists
Construction
Consulting
Designing

Professional Services

Space limited to AIME members or to companies that have at least one member on their staffs.
One inch, $40 per year; half inch, $25 payable in advance.

G. CANNING BARNARD
Mining and Geological Consultant
East and Central Africa and the Rhodesias
P. O. Box 705 Nairobi, Kenya Colony. Tel.: 3319

BLANDFORD C. BURGESS
Mining Engineer
Industrial Minerals Specialist
Box 330 Monticello, Ga.

GLENVILLE A. COLLINS
Mining Engineer
Uranium examinations Cable "Colns"
210 La Arcada Bldg.
Santa Barbara, Calif.

COWIN & CO.
Mining Engineers & Contractors
Consulting Shaft & Slope Sinking
Appraisal Mine Development
Reports Mine Plant Construction
900 2nd Ave., No., B'ham, Ala. Phone 3-4271

HUBERT O. DE BECK
Consulting Geological Engineer
CERAMIC RAW MATERIALS and
INDUSTRIAL MINERALS
P. O. Box 323 3100 Speedway
Custer, South Dakota Austin 21, Texas

PAUL F. DEISLER
Management Consultant
Member: S.A.M., N.A.C.A., A.M.A.
820 Mills Bldg. El Paso, Texas

EDWIN S. GILES
Consulting Mining Engineer
In Goldfield since 1905
Goldfield Nevada

CARLTON D. HULIN
Mining Geology
26th Floor San Francisco 4
Shell Building California

LEDOUX & CO. INC.
Assayers Chemists
Shippers representatives at all seaports and refineries in the United States
155 Sixth Ave. New York

T. E. LLOYD
Sintering Consultant
Room 2700 70 Pine St.
Wh. 4-2300 New York 5, N. Y.

MARK C. MALAMPHY & CO. LTD.
Consulting Geologists and Geophysicists
P. O. Box 290, Mufulira, Northern Rhodesia
Experienced field crews available for examinations and surveys anywhere in Africa.

JOSEPH T. MATSON
CONSULTING MINING ENGINEER
Examinations—Appraisals—Operations
P. O. Box 170 Santa Fe, New Mexico

CLAYTON T. McNEIL, E. M.
Mine Examination, Reports, Supervision, Operation
822 Bank of America Bldg., Tel GArfield 1-2948
SAN FRANCISCO 4, CALIFORNIA

ARNOLD H. MILLER
Consulting Engineer
Mine, Mill and Industrial Investigations
Improvement Design and Recommendations
Cable: "ALMIL" Tel. Cortlandt 7-0635
120 Broadway New York 5, N. Y.

WILLIAM A. O'NEILL
Registered
Consulting Mining Engineer
Alaska and Yukon Territory
Box 2000 Anchorage, Alaska

RODGERS PEALE
Consulting Mining Geologist
315 Montgomery St.
San Francisco 4, Calif.

ROGER V. PIERCE
Mining Engineer Specialist
Underground Mining Methods. Cost Cutting Surveys—Production Analysis—Mine Mechanization
Mine Management
40 East 9th South Salt Lake City 4, Utah

LUCIUS PITKIN, INC.
Mineralogists
Assayers—Chemists—Spectroscopists
Shippers' Representatives
Pitkin Bldg., 47 Fulton St., New York
Cable Address: Niktip

MILNOR ROBERTS *Consulting Mining Engineer*
The Pacific Northwest, British Columbia and Alaska
4501 15th Ave., N.E. Seattle, Wash.

PAUL F. SCHOLLA ASSOCIATES
Metal & Non-Metallic Mineral Mining Examination. Management. Development. Surface Plant Design. Financing.
1025 Connecticut Ave., N.W. Washington, D. C.

SEWELL THOMAS
Consulting Mining Engineer
Plant Layout, Design, Detailing, Mechanization, Mining Methods
380 Gilpin St., Denver 3, Colo.

WM. HUFF WAGNER
Mining Engineer and Geologist
Examinations, Reports and Appraisals
631 Tower Building Washington, D. C.

LELAND A. WALKER
Consulting Mining Engineer
Management, Mining Methods, Examinations
140 So. West Temple St., Salt Lake City 1, Utah

O. W. WALVOORD CO.
Mill-Design and Construction
401 High St. Denver 3, Colo.

O. BARLOW WILLMARTH
Mining Consultant
Georgetown, Colorado

WALKER & WHYTE, INC.
Assayers, Chemists
Shippers Representatives
409 Pearl St. (Corner New Chambers), New York
U. S. A.

HARRY J. WOLF
Mining and Consulting Engineer
Examinations—Valuations—Management
429 Madison Avenue, New York 17, N. Y.
Cable: MINEWOLF Tel.: Plaza 9-1700

ALLEN & GARCIA COMPANY
38 Years' Service to the Coal and Salt Industries as Consultants, Constructing Engineers and Managers.
Authoritative Reports and Appraisals
332 S. Michigan Ave., Chicago
120 Wall St., New York City

B. B. R. DRILLING CO.
Scenery Hill Martins Ferry, O.
Diamond Core Drilling Contractors
Mineral Foundation
Cores Guaranteed Testing

BOOTH ENGINEERS
LIONEL E. BOOTH, MANAGER
Consultants in Metallurgy • Ore Testing Plant Operation • Process and Equipment Development
72 WEST SECOND SOUTH
SALT LAKE CITY 1, UTAH

DIAMOND DRILLING IN MEXICO
New Equipment
Experienced Drillers
THEODORE A. DODGE
215 Av. Obrego N., Nogales, Sonora, Mex.
201 North Court St., Tucson, Arizona

M. G. DRIESSEN
Consulting Engineer
Coal Preparation, Heavy Medium Cyclone Thickeners, Washers and Concentrators
260 Jefferson Drive, Pittsburgh 16, Pa.

EAVENSON & AUCHMUTY
MINING ENGINEERS
Mine Operation Consultants
Coal Property Valuations
2720 Koppers Bldg. Pittsburgh 19, Pa.

MILTON H. FIES
Consulting Engineer
Rooms 1201-2
Alabama Power Co. Bldg.
Birmingham, Alabama

CHESTER A. FULTON
Consulting Mining Engineer
10 East 40th St. New York City 16
Murray Hill 9-1530
302 Somerset Rd. Baltimore 10, Md.
Belmont 1353

T. W. GUY
Consulting Engineer
Coal Preparation
TO YIELD MAXIMUM NET RETURN
FACE AND PRODUCT STUDIES
PLANT DESIGN AND OPERATION
Kanawha V. Bldg. Charleston, W. Va.

ABBOT A. HANKS, Inc.
ASSAYERS-CHEMISTS
Shippers Representatives
624 Sacramento Street
SAN FRANCISCO

INTERNATIONAL SERVICE BUREAU INC.
Washington Representatives for the Mining Industry—Brokers of Mining Machinery
Expedition of Export Licenses
1025 Connecticut Avenue, N.W.,
Washington 6, D. C.

JOSEPH R. LINNEY
Consultant
MINES • MILLS • METALLURGY
30 Years' Experience Adirondack Magnetites
38 Clinton St. Plattsburg, N. Y.

Authors

(Continued from Page 27.)

sion in World War II, and took over his present post last year. . . . **Lendall P. Warriner** (p. 376): Born in Seattle, Wash., he attended St. Marks School in Southboro, Mass., and in 1914 graduated, magna cum laude, from Princeton Univ. with an A.B. in geology. Graduate work at MIT, 1941. He has been with Lehigh Coal and Navigation Co., Sunshine Mining Co., International Mining Corp., and was a lieutenant commander in the Navy during the recent war. AIME Member since 1935. Since 1947 Mr. Warriner has been president of the Appalachian Minerals Co. He lives in Monticello, Ga. Fishing, golf, and bird watching are numbered among his pastimes. **Thomas L. Kesler** (p. 371): Born in Salisbury, N. C., and attended Salisbury High School. B.S. in geology, Univ. of North Carolina, and M.S. in geology in 1930. He has worked for the Shell Petroleum Corp., the Soil Conservation Service, and is now a geologist in the southeastern states for the U. S. Geological Survey. Mr. Kesler is an AIME Member, resides in Cartersville, Ga., and in his spare time enjoys photography. . . . **R. W. Diamond** (p. 38): Born in Campbellford, Ontario, Mr. Diamond attended Campbellford High School, then took his B.A. Sc. degree from the Univ. of Toronto. Also holds an LL.D, (Queen's Honorary). Now vice-president and general manager, Consolidated Mining & Smelting Co. of Canada; president, West Kootenay Power & Light Co., vice-president and director Alberta Nitrogen Products, Ltd.; and vice-president and director, Montana Phosphate Products Co. Member of AIME since 1918. He resides at Trail, B. C., and relaxes on the golf links. . . . **B. P. Sutherland** (p. 38): Born in Birkenhead, England, and attended Birkenhead Institute. Then the Univ. of British Columbia, and McGill University. Holds B.A. Sc., M. Sc. and Ph. D. degrees. He has been with the Research and Development Division of the Consolidated Min. and Smelt. Co. of Canada since 1929, and is now chairman of the research board of that Company. . . . **J. G. Evans** (p. 46): Born in Bountiful, Utah. Studied mining engineering at the University of Utah. Field engineer for the Gardner-Denver Co. in the Union of South Africa and German Southwest Africa from 1939 to 1946. Four years as general manager of tungsten and corundum mines in South Africa. Now with Gardner-Denver's Kansas City branch. Mr. Evans enjoys fishing, hunting, golf, and photography. He brought back over 4000 ft of color motion picture film from Africa, which opus on African wildlife earned him a membership in the Adventurers Club of Chicago. . . . **R. L. Powell** (p. 365): Born in Hallsville, Mo. and attended Sturgeon, Mo., High School. B.S. in chemical engineering from the Univ. of Missouri in 1942. He was with the department of chemical engineering at TVA's Wilson Dam in Alabama until 1946. Now title development engineer with the titanium division of the National Lead Co. in South Amboy, N. J. Mr. Powell enjoys woodworking in his spare time.

Personnel

(Continued from Page 25.)

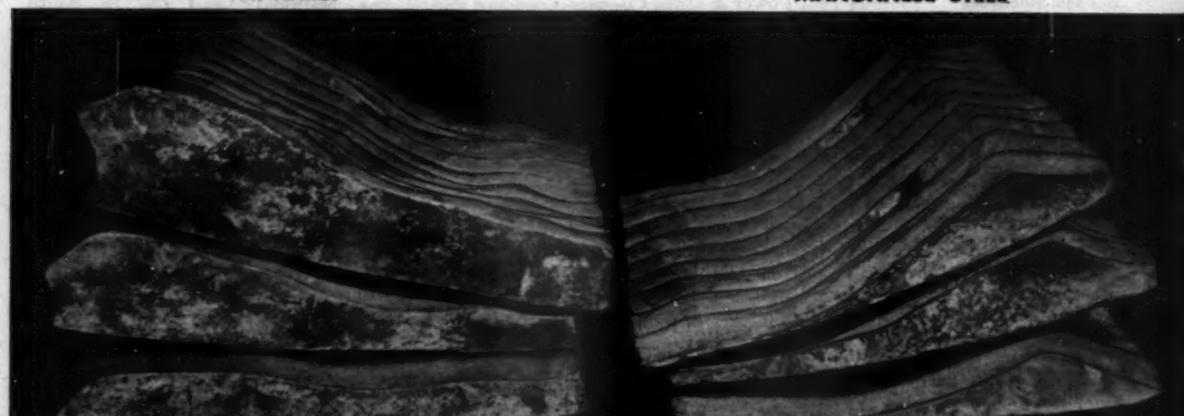
sion of production, establishment of production standards, and analysis and interpretation of cost statements. (b) Industrial Engineer, 28-35, four years' experience in mechanized mining to supervise two to four junior engineers in the establishment of production standards, analysis of haulage, communication, and power distribution problems. Should have the ability to grow into a job as superintendent. $5400-$6600 a year. West Virginia. Y-2805.

Men Available

Mining Engineer, B. S., 38, married. Six years' experience strip mining anthracite and bituminous coal for large company; 10 operations, in charge of engineering. Previous experience included surveying, mapping and mine development of underground anthracite mines. Desires position in open pit mining. M-467.

Mining Engineer (Reg. P.E.), comprehensive training mining and extraction metallurgy. Experienced all phases operation, examination; raw materials supply on international level, especially Europe and Far East. Nine years' mine operation; 4 years' metallurgy, 7 years consultant, lecturer 5 years, (P-6 U.S. Army ordnance). Seeks permanent connection responsibility. Married, no children. M-468.

Mining Engineer, 34, married, technical graduate. Eleven years' practical experience in South African gold and base metal mines. Conducted numerous geological surveys and directed prospecting and mining operations. Head office experience with sound all around training. Widely travelled. M-470-124-Chicago.



* Titanium ingots weighing 65 lb have been made by Allegheny-Ludlum at Watervliet for sometime. Within several weeks 100-lb ingots will go into production and 400-lb ingots are planned by year's end. Allegheny-Ludlum has taken a sizable order for large titanium forgings to be used in gas turbines. The company will accept orders for wrought titanium in about any form, the price being on the order of $20 a lb for strip. It is expected that this price may drop to a mere fraction of this level within several years—probably to a level competitive with stainless.

* George H. Livengood, financial secretary of Local 6308 of the miners' union, in Fayette County, Pa., filed suit in the Federal District Court, Washington, D.C., on Sept. 22 demanding from the trustees of the United Mine Workers Welfare and Retirement Fund an accounting for $140,000,000 alleged to have been spent since 1946. He charged that Trustees John L. Lewis, Senator Styles Bridges, and Ezra Van Horn had "wrongfully dissipated" fund payments.

* Comparatively few cancellations by foreign buyers for United States goods have developed thus far as a result of the wave of currency devaluation, exporters reported in New York on Sept. 22. Devaluation was seen as increasing prices of American goods by some 30 to 40 pct in the devaluated currencies.

* Low-grade and microscopically fine uranium-bearing pitchblende has been reported found on property of the Sunshine Mining Co. near Kellogg, Idaho. "The grade of the material is low in relation to the narrow widths, and we do not consider the discovery to be of present economic importance," said Ross D. Leisk, general manager. The Atomic Energy Commission is attempting to get all mine operators to check their ore bodies and tailing piles for uranium bearing minerals.

* The Senate Banking and Currency Committee unanimously reported the Administration bill setting up guarantees for private capital invested abroad against the risks peculiar to such investment. The guarantees clearly cover the risk of inconvertibility, but the risks of confiscation and physical destruction will be studied by the Export-Import Bank.

* Importation of Russian manganese and chrome ore has been resumed with the easing of American export regulations to the Soviet. $500,000 worth of oil machinery has been approved for shipment.

* International agreement to use the name of Wolfram, instead of century-old tungsten, and to accept official names for thirteen other elements was announced at the American Chemical Society's national meeting in Atlantic City.

* Continued insistence of some segments of Canadian industry to import large quantities of United States coal in preference to the domestic product may result in the Canadian government clamping a partial embargo on coal imports.

* Richard D. Hoak of Mellon Institute reported before the AIChE that a 60 pct manganese concentrate can be made from 10 to 20 pct ores by a process involving treatment with acidic liquor, selective removal of sulphate and iron impurities and isolating of manganese in the form of the oxide.

Mining Engineering *Editorial*

Politics Before Conservation

A FEW weeks ago a representative group of the world's scientists and engineers conferred without fanfare on the outlook for the human race. The delegates to this conference, which was sponsored by the United Nations to study the conservation of world resources, were not empowered to set policy but merely to exchange information. This was as it should be, for many more conferences will be needed before this subject can be discussed on a worldwide basis. Present limitations were delineated by the disparate problems of the participating nations which could be divided into three broad classifications or groups, as follows: (1) Those nations with undeveloped resoures and large populations supplying cheap labor; (2) Nations whose resources have been exploited and whose large populations within narrow political boundaries are dependent on imports; (3) Those which are at the peak of exploitation of bounteous resources and are producing surplus commodities.

A discussion over whether the conference should consider conservation in consumption rather than conservation in production illustrates the necessity for agreement on the national level. Although conservation in consumption is scientifically logical, to advocate it smacks of socialism. Thus American delegates were, for the most part, in a quandary, whereas the English scientists could support it with clear consciences.

Using material standards as a basis for comparison, more was accomplished at a widely heralded meeting in Washington which was held less than a week after the UN meeting, in which the political counterparts of the scientists representing nations in the latter two groups, mentioned above, were delegates. Without the benefit of natural science, and without mentioning conservation or utilization of resources, the immediate or short-range problems of the participants were discussed. It looks as though one outgrowth of this meeting will be the creation of new wealth by currency manipulation rather than by digging or tilling the soil.

Resources and their economic ramifications are intimately related but any discussion of them transcends even these broad limits, entering the realm of politics. Thus many preliminary meetings are needed to crystallize the problem for each country and to formulate objectives before a world conference can hope to reach a basis for action. Even so, little can be done before the one-world concept is accepted so that one country is free to supply what another lacks in materials or know-how.

Natural science has made strides over the years as has the science of government. The two must co-ordinate their efforts in behalf of their mutual destiny before it is too late, and lest we bequeath a plundered planet to our descendants.

It's Everyone's Business

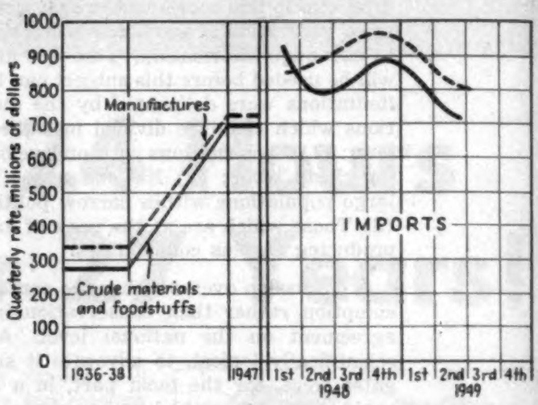
WITH summer's record heat tempered, the month of September was marked by a great scurrying of politicos in and out of Washington. Congressmen drifted into the hinterland at the slightest opportunity to rest their jangled nerves and mend fences. Out in Pittsburgh and Des Moines, the epicenters of labor and agriculture, Mr. Truman mounted his campaign charger and unfurled his battle-flag for 1952. He pridefully spoke of his record—not as tarnished as sometimes suggested—but made no attempt to gloss over failure to repeal the Taft-Hartley Labor Act. Meanwhile, the father of this Act, Senator Taft, also chose Labor Day to start visiting every county in Ohio in preparation for his trial by vote in 1950. If he is defeated next year the Republican conservative wing may be permanently crippled; if he wins he can hardly avoid being the strongest contender for standard bearer in 1952. And, also on Labor Day, General Eisenhower, speaking before the American Bar Association, gave every indication of willingness to grasp the same standard if the Republicans would care for a nice middle-of-the-road contender.

Meanwhile, confused and harried Britains and Canadians conferred with their American opposite numbers in Washington in an eleventh-hour effort to somehow resolve the desperate world dollar problem. What Mr. Bevin described as "perhaps the most momentous talks of all time" ended with a 3000-word statement from the finance ministers so bland and commonplace as to be a source of much puzzlement on both sides of the Atlantic. What concessions there were seemed to be all one way, from North America to Britain. But within a week the British paid the piper with a long-overdue, drastic and immediate devaluation of the pound sterling. Practically all the world's currencies then toppled in a mad rush to maintain pre-devaluation ratios.

By indulging in some highly optimistic flights of conjecture many attempts were made to translate all these moves into a tidy British "balance sheet" for 1952 to show an equalization between outgo and income. But there is little justification for regarding devaluation, even in conjunction with the other measures of agreement in the Washington talks, as any means of economic salvation, either in Britain or Western Europe. Devaluation, if it is to be other than a futile gesture, will have to be accompanied by unpleasant forms of retrenchment and energetic effort to achieve greater productivity.

The British worker will have to work longer and harder to send far more goods to the United States just to maintain current dollar sales. This means a further serious drop in the standard of living of Britain and Western Europe, and the political repercussions can well be quite violent. Even so, there can be some doubt as to whether in 1952 there will be a balance between what Europe needs from the dollar area and what Europe sells to the dollar area. The dollar sales in the Marshall group of countries have declined by 30 pct in the past six months (see graph), and if this drift is not halted the hunger and unemployment prophesied by the assembly at Strasbourg will not wait even until 1952.

Granted the British master all these difficulties, there is still another hurdle to cross in order to lift deliveries to the United States to near the calculated levels for 1952. The Washington talks promised a review of tariffs and customs procedure in the United States, but during the same week the relatively mild Reciprocal Trade Agreements Act just squeezed through Congress with the slimmest of margins. In short, Congress has never cared to pursue policies appropriate to a great creditor nation or to ease the way for repayment of the billions of dollars pumped out over the past several decades to subsidize exports.



Americans keep advising Europeans to expand their exports to the United States. Even Mr. Hoffman has been guilty of some guile when he recently said that American tariffs are no higher than in 1914 and insinuated that they could hardly be a bar to greater imports. But in 1914 the United States was probably the most highly protected country in the world, and today its tariffs are quite high when viewed in the light of the country's record position as an exporter and creditor power. Today, duty on imports of machinery are 12½ pct, rising to 40 pct for textile machinery. On bicycles the duty rises to as high as 30 pct, cutlery pays up to 35 pct, glass up to 40 pct, boots and shoes 20 pct, hosiery 50 pct, and clocks in some cases up to ad valorem rates of over 200 pct. Superimposed on all this is a set of rules and regulations specifically designed to discourage or to delay. Many onerous restrictions stand in the way of foreign enterprise attempting to operate in the United States, of which the situation in shipping is the

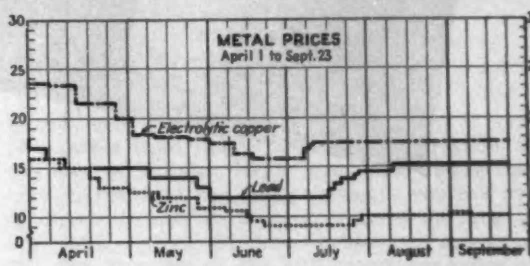
most notorious. All this is hardly likely to be changed without prolonged and anguished outcries from Congress. But the alternative is further outright gifts of money abroad, with no inclination or intention of accepting anything in return. It is a policy likely to make many a future historian's eyes bulge with disbelief.

The tide of recession in the United States turned sharply in August, much to the pleased surprise of all pundits. September was everyone's favorite for the turn. The Federal Reserve Board's August index on industrial production rose all the seven points it had lost in July, this being the first upward movement since October 1948. At the same time the Census Bureau for the first time this year reported a decline in unemployment, down 400,000 to 3,689,000. But still some 2,000,000 persons continued to work part-time, from necessity rather than choice, which is about double that of a year ago, but not appreciably changed since last May. The impetus behind this improvement was partly seasonal and partly sparked by restocking to fill out inventories on a rising price curve. Preparations for the Christmas trade, particularly in the consumer goods, would normally carry this autumn upswing on through the turn of the year. But the entire labor situation is in such a turmoil as possibly to put a painful crimp in the curve of economic recovery.

Base metal prices (see graph) wallowed in a trough of indecision through most of September under the twin impacts of a rising industrial curve and a deteriorating labor situation. There has been the usual seasonal increase in buying activity, some cautious replenishment of depleted stocks, but prices in general show no real recovery from the unwarranted declines earlier in the year. In zinc, the galvanizers have been in the market regularly but diecasters came in for a little and are quickly out. Battery manufacturers are taking sizable quantities of lead and the demands for electrical equipment, which account for half the consumption of copper, have been well maintained and even show some recent improvement. Copper is now (Sept. 23) 17.625¢ a lb compared with 16¢ two months ago and 23½¢ last March. Lead is 15.125¢ compared with 12¢ at mid-July and 21½¢ in March. Zinc is 10¢ compared with its low point of 9¢ two months ago and its earlier peak of 17.50¢. As regards production, output from American mines has fallen off but world output continues to rise. There are no signs of surpluses, however, least of all in lead.

On the labor front Mr. Murray was in the downstage spot all month; Mr. Lewis carried on his independent show off in a corner, and Mr. Reuther, the rubber workers and a host of other unions, marked time in the wings awaiting their cues. The employers rallied in earnest for a real fight, with practically no deflections in their ranks. The issue was security to be totally financed out of the yields of the risk-takers. Just how much room is left in the American economy for the worker to increase his share of business profits is probably something on which employer and employe will never agree, but for the first time in nine years there was no insatiable consumer demand to foster collusion between them and thus avoid the basic issue. Both sides brought up such a show of force to leave little room for retreat without serious loss of face.

Even while the labor aristocrats drove for security, their lowly brethren were given a hand up early in September by Mr. Truman as he redeemed still another of his campaign pledges. (Others: Atlantic Pact, Wheat Agreement, Housing Act, stop-gap farm price legislation, Military Assistance Program.) The Senate, all in a hurry to get home for a six-day holiday, rushed through an advance in the national minimum wage from 40¢ to 75¢ an hr. This was the first change since a rather meaningless 40¢ was passed in 1938.

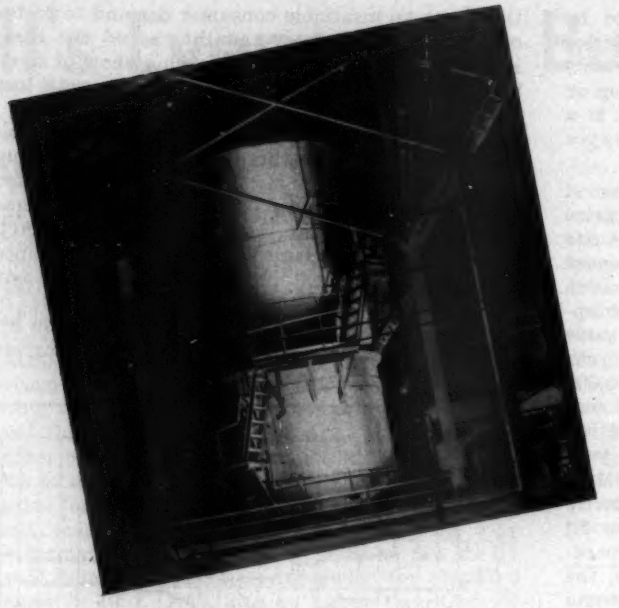


Almost forgotten amidst portentious happenings elsewhere in the economy are the limited geographic areas which continue to show such serious unemployment that the situation may become chronic without government help. Whereas the national average of unemployment is now less than 6 pct of the total labor force, there are eleven areas with over 12 pct unemployment, and a few smaller areas may soon be added to the list. In these limited areas unemployment compensation has so far acted as a buffer to the local economy, but from now on the benefit rights will begin steadily to run out.

With the exception of Knoxville, Tenn. and Muskegon, Mich., all the eleven distress areas are in the northeastern corner of the U. S. and six are in New England. In Lawrence, Mass., 37 pct of the labor force is out of work, and in the Providence area, which is tantamount to the whole state of Rhode Island, one out of every five workers is unemployed. The chief industries in these depressed areas are consumer goods, all early victims of the recession—textiles, shoes, jewelry, machine tools, electrical goods and so on.

The improvement in the general economy has already helped the textile and leather industries. Furthermore, Mr. John Steelman, the President's adviser, has instructed the ten chief government spending agencies to shift their procurement activities whenever possible to the eleven areas, and public works and other government activities already planned for these areas will be speeded up. It is expected that all these activities will pump some new life into these eleven areas by year's end. It's mostly a form of robbing Peter to bolster Paul, but so far no one has cared to suggest an optional course.

New Processes for



New processes are exemplified by this 12-ft diameter 100 ton per day fluidizing reactor for producing high-quality lime. This first installation for making lime by the Dorrco system belongs to New England Lime Co.

Low-grade ores can be designated by two main classifications: (1) simple low-grade ores, and (2) complex low-grade ores. As a rule the first type has a relatively small metal content, although low-grade iron ores contain a rather high percentage of metal. As the simple type is the one that is ordinarily in mind when the term "low-grade ore" is used, the paper will be devoted mainly to ores in this general category. Cheap treatment is the prime requirement in utilizing low-grade ores of the simple type, although in some cases the value of nonmetallic by-products, such as limestone for fertilizer and silica for flux, allows a little more latitude than in the usual situation. When the costs are divided under the three headings—mining, milling, and smelting—it is apparent that the last group will not constitute an important factor as a rule because the high concentrating ratio makes the smelting cost per ton of ore fairly low.

Crushing and grinding costs form a large part of the total milling charge, and therefore economical size reduction is a prime requisite for the successful treatment of an ore of low metal content. Recent advances have been mainly in the direction of larger and more powerful machines that handle coarser sizes and require less attention and repair. In addition the increased use of automatic controls and mechanized handling of materials have been very noticeable and have effected considerable savings in labor costs.

As an indication of the size of the equipment now available, it might be mentioned that manufacturers offer, for example: jaw crushers, with openings up to 86 x 66 in. and capacities of about 1000 tons per hour, and gyratory crushers with 60-in. openings and up to 3000 tons per hour capacity. There are in use 84 in. diameter crushing rolls operating at peripheral speeds of 3500 fpm and a rod mill recently installed in British Columbia has an inside diameter of 10½ ft and is 12 ft long.

Other equipment in general use includes hammer mills, ball and tube mills, and roller mills. The various types of equipment are frequently operated in closed circuit with screens, classifiers or other size separators to obtain most economically the degree of size reduction required.

An interesting example of the use of automatic controls is the patented system employed by the Utah Copper Co. to regulate the feed to the crushing roll circuit so that this circuit always operates at maximum efficiency. The control of the return of classifier sand to the grinding mill also has received much attention. Utah Copper Co. engineers were assisted by the General Electric Co. in devising the proper electrical equipment. A roller device on the return end of the classifier continuously measures the thickness of the ribbon of oversize sand being returned to the ball mill. When the ore is hard, the circulating load in the classifier increases and the increased thickness of sand raises the roller which automatically increases the speed of the rakes through control of the variable speed a-c motor drive. When the ore is soft, the circulating load decreases and causes the regulator to decrease the speed of the rakes in order to avoid excessive turbulence in the settling pool of the classifier.

A closely related subject is the increased mechanization in handling materials, as exemplified by the use of conveyor belts, power shovels, and loaders—all larger, more rugged, and of higher capacity than before.

The early discarding of waste rock is important

Low-Grade Ore Concentration

by R. W. DIAMOND, C. O. SWANSON and
B. P. SUTHERLAND

and economically sound only if sorting can be done cheaply. Heavy density methods are especially well adapted for this purpose. In addition, other gravity processes, magnetic separation, and flotation have been greatly improved in recent years. The use of

Messrs. Diamond, Swanson, and Sutherland are, respectively, vice-president and general manager; chief geologist; and chairman of the research board of the Consolidated Mining and Smelting Co. of Canada. This article is a condensation of one prepared for the United Nations Scientific Conference on the Conservation and Utilization of Resources.

grinding characteristics that permit sorting by screening, with or without some preliminary treatment such as calcination, is also noteworthy.

Flotation has been called the "work horse of the milling industry" both in sulphide and nonsulphide fields. Although many of the recent improvements have been in connection with the treatment of complex rather than simple ores, notable advances in the way of building larger machines, discovering cheaper reagents, and using automatic controls are of direct interest in large operations on ores of low metal content. Flotation constitutes an essential step in many of the well-known examples of utilizing low-grade deposits. Magnetic seperation is used mainly in connection with iron ores, often after a preliminary magnetizing roast. The improved means of generating magnetic fields that are now available constitute a development of fundamental significance.

Methods that make direct use of differences in specific gravity are probably the most important of all because they are inexpensive and have recently been improved with respect to their utilization in the treatment of the simple type of low-grade ore.

Heavy density processes have had an especially rapid growth in the last few years. In general

The Heavy-Media separation process minimizes selectivity in mining. It is used to clean coal at the Alpheus plant, Gary, W. Va., of the U. S. Coal & Coke Co.

they are applied to sizes of four mesh and greater although some progress has been made in handling finer particles. Separation is obtained by introducing the ore into a cone which contains a heavy medium consisting of an aqueous suspension of finely divided ferrosilicon, magnetite, or galena. The light gangue particles rise and the heavier mineralized particles sink.

Favorable results were noted recently in large-scale tests wherein a modified Akins classifier was used as the separating vessel for heavy density concentration. The spiral of the classifier removes the sink product and the design of the spiral lifting device permits raising the spiral and shutting down the separator without the necessity of draining the vessel. The selective-media concentrator developed by the Stearns-Rogers Manufacturing Co. differs from the ordinary heavy density devices in that the ore itself forms the medium, and it can treat much finer ore than is usually treated in the heavy density machine. Experimental application to iron ore concentration has been promising, and wide application to the beneficiation of low-grade nonferrous ores is indicated.

The broad utilization of heavy density principles can be illustrated by citing a few examples. In addition to the well-known applications in the Mesabi iron range and the Tri-State and Coeur d'Alene districts, the process is employed to concentrate tin ores in Bolivia and fluorite, manganese, copper-tungsten, tin-tungsten and other ores in various parts of the world. Engineers of the Dutch State Mines have developed a process that can treat coal as fine as 48 mesh and is generally applicable to particles of moderately fine size.

Passing on to other gravity methods, we note that a high frequency jig, operating at 3600 impulses per minute, has shown promise in the Lake Superior district. The coal industry of the United States has spent large sums on research and has developed, among other devices, a machine that represents a notable advance in jig and table design. United Mining and Milling Corp. have expanded their operations in handling manganese ores, the backbone of the process being a redesigned Hancock jig.

The Humphreys spiral is one of the simplest continuously operating mechanical devices employed in the concentration of minerals. It uses centrifugal action but has no moving parts and requires no direct power to operate. The pulp, usually minus ten mesh, flows down a spiral launder, and the heavier ore particles are drawn off through ports on the inner side. By splitting the tailing as it flows from the spiral, it is possible to separate sand and slime and also to make a middling product for recirculation or separate treatment. The concentrate from the rougher spiral may be further enriched by retreatment in cleaner spirals or by flotation.

The spiral has found commercial application in the concentration of zinc, lead, silver, chromite, rutile and ilmenite from beach sands and in the washing of coal. Other possible applications include the treatment of iron, tantalite, columbite and tin ores, tailing from gravity and flotation plants, and placer deposits containing gold, silver, corundum, garnet, monazite, zircon or other heavy minerals. An example of Humphreys spiral performance is the production of a five percent concentrate from a tailing that assays 0.15 percent WO_3. Tables can then grade it up to 65 percent WO_3. Automatic controls and mechanized handling of materials are partly responsible for the improved efficiency of collecting devices. As in the case of crushing and grinding, and in fact in all phases of ore treatment, the increased use of controls and mechanization are important factors in cutting costs.

In actual practice the successful treatment of a low-grade ore does not usually depend on a single key process but on the co-ordination of many steps, each of which is developed to a high degree of efficiency according to the particular requirements and in relation to the other phases of the whole operation. The following examples, which are only typical of many, illustrate what can be done along these lines.

At the Alaska-Juneau operation the recovery during 1934-1937 averaged only .043 ounce of gold per ton mined. The elimination of waste rock before milling, which was done by hand sorting, was a critical factor in the over-all cost as a large proportion of the product from the mine did not contain enough values to pay for milling it.

The low-grade taconite reserves of the Mesabi

This Mobil-Mill makes a shipping-grade iron ore by the Heavy-Media process for Rhude & Fryberger at Ironton, Minn.

The 10,000-ton Sullivan concentrator of COMINCO, near Kimberley, B. C., is finding the Sink-and-Float process for separation particularly adaptable to their lead-zinc ore.

Range are tremendous, amounting to some 60 billion tons averaging about 30 percent iron. The mineralogy is in general simple, as the taconite consists essentially of hematite, magnetite, and chert. In normal taconite, hematite is the main iron mineral, but at the east end of the range where the iron formation has been metamorphized by the Duluth gabbro, magnetite becomes abundant. The utilization of this vast resource is still in the experimental stage but two large proving plants are showing the way. It appears that magnetic concentration, perhaps preceded by a reducing roast, will prove the outstanding method. However, various combinations of processes are being tried, and include the use of heavy media, classification, and flotation, as well as magnetic separation.

The Greater Butte project contemplates the utilization of the low-grade deposits that are associated with the main veins, and the treatment of 130 million tons over a period of years is visualized. Experts of the Anaconda Copper Mining Co. have their plans crystallized for the economic extraction of ore that will return 20 pounds of copper per ton, together with substantial credits in precious metals. From the technical viewpoint, the development of new flotation processes is perhaps the main factor in the treatment of the ore.

Another well-known example that has proven the possibilities of utilizing low-grade copper deposits is the operation of the Utah Copper Co. at Bingham. By employing the most efficient procedures in open-pit mining, milling, and smelting the Company has been able to make substantial profits by large-scale methods that treat about 80,000 tons a day averaging around 0.9 percent copper. Favorable factors are the large size of the deposit, the facilities for mining, and the mineralogy of the ore.

In the lead-zinc field a recent example is furnished by the program in the Coeur d'Alene district. In addition to the treatment of old tailings, the mining of low-grade ores left in the walls of the stopes will be undertaken on a large scale. The deposits occur as replacements along fracture zones, and there are large blocks of slightly mineralized ground that were left in the first operations. In the treatment of the low-grade material, heavy density has been used, although it is probably true that the burden of the separation falls on flotation.

As a final example we will take one aspect of the operations at the Sullivan mill of The Consolidated Mining and Smelting Co. of Canada. This aspect is the recovery of tin from the tailing obtained from the normal concentration processes for the lead and zinc. The tailing carry about one pound of tin per ton, as cassiterite, and the initial problem was to obtain a preliminary separation that would discard most of the waste material and leave a product that could be regarded as a normal tin ore. The first step is desliming, followed by flotation of the underflow in which over 60 percent of the material is floated as iron sulphide relatively low in tin. The remaining 2000 tons are treated on a novel automatic tilting blanket table, carried out in two stages with an intervening flotation step. The bulk of material is thus reduced to about 30 tons, containing up to eight percent tin and amenable to standard gravity separation procedures.

The second class of low-grade ores includes materials that contain fairly high gross values in metals but, because of their complexity, yield only a small margin of profit when treated by standard methods. They can stand large treatment costs, which opens up a wide field of technological attack. In flotation, the use of induced superficial oxidation has advanced rapidly in the last few years. The principle is that carefully controlled heating in the range of 250 to 500C will produce an oxide film on one mineral while another remains unaltered. The separation of the minerals can then be carried out by standard flotation procedures. Ultimately it may be possible to make such difficult separations as sphalerite from partially oxidized copper sulphides, galena from tetrahedrite, nickel sulphides from copper and iron sulphides, and even auriferous iron sulphides from barren iron sulphides.

To illustrate what is being done along these lines, it may be noted that at a large concentrator in Utah a mixture of chalcopyrite and molybdenite, which has been depressed from the copper concentrate, is heated to about 275C in a hearth roaster and then repulped. The molybdenite is floated from the chalcopyrite, which is rendered

International Nickel uses rolls in the preparation of their ore for flotation at Copper Cliff, Ont. Changes in their preparation technique are being made.

nonfloatable by the heating process. The ratio of MoS_2 to copper in the final concentrate is more than 2600 times the ratio in the original.

Another example is the concentration of a chalcopyrite-cobaltite ore assaying about 0.9 percent cobalt occurring in a large deposit in the United States containing up to 40 percent pyrite and pyrrhotite. The job is being done by floating a finished copper concentrate and a bulk sulphide concentrate in the rougher circuit. A superficial oxide film is then formed on the iron sulphides in the bulk sulphide-cobaltite concentrate by heating to 300C, thereby making it possible to depress the iron sulphides and float the cobaltite.

In this connection mention must be made of the use of a fluidized bed for roasting and calcination. This is a new development that allows treatment under closely controlled conditions and may find application in connection with problems of the type just described, as it is doing in other operations.

A different form of pre-treatment for flotation is the process developed by International Nickel Co. in which a copper-nickel matte is slowly cooled so that crystallization of the different constituents is sufficiently coarse to allow separation by grinding and flotation. This is an example of co-ordination in which metallurgical transformations are carried out with a view to subsequent flotation. The principle would seem to be capable of fairly widespread application.

Improvements in the reagents used in flotation have led to a number of new procedures. For example, certain manganese ores can be handled by employing a cationic reagent that causes the gangue to be floated, and a mine in North Africa is successfully treating a badly oxidized lead ore by using a special sulphidizing reagent.

Passing from flotation to other methods we note that electrostatic separation has again been receiving considerable attention and in some fields has been developed to the point of commercial application. One factor in the operation is the surface pre-treatment of the ore particles.

Automatic sorting on the basis of color is already established in various industries and should be applicable to certain ores. The process need not be limited to visual differences but could include reflectivity, fluorescence, and transparency to various radiations including X-rays. X-ray transparency has already been used on a small scale for sorting coal. Natural radioactivity of uranium, thorium, and potassium minerals, and artificial radioactivity of others has interesting possibilities for research and development.

During the last few decades the mineral industry, in all its phases, from prospecting for ore to marketing the finished product, has made great progress. This is demonstrated by higher efficiencies, lower costs, and better working conditions. It is believed that in good part this progress has been achieved by industrial research and development using, in co-operation, the advances made in many individual lines of science and engineering to further the industry as a whole. In North America, at least, there has been a remarkable recognition of the mutual advantage gained by free interchange of technical information not only between engineers in various fields but also between various companies. It is believed that experience has amply proved the merit of this practice. If the problems involved in the adequate development of the world's mineral resources can be approached in a spirit of true co-operation and partnership, the results already achieved can be surpassed and multiplied many times throughout the world for the benefit of the whole of mankind.

Many of the ideas contained in this paper have been drawn from sources that would be difficult to specify, and to all these people the writers are under deep obligation. In addition, special mention must be made of the work done in the preparation of the material by F. M. Ethridge, H. R. Banks, W. G. Jewitt, and S. Gray of the staff of The Consolidated Mining and Smelting Co. of Canada.

Survey Rates Engineers' Personality

Intelligence is the most highly sought after personal quality in an engineering employe in the opinion of 44 of the nation's top-level engineering executives, who participated in a survey recently concluded by the Engineers' Council for Professional Development to provide facts about human personality which would be valuable in its program of student and professional development.

The results of the three-year survey which was broadened to include opinions of college administrators, faculty, personnel officials, and engineering students, are published in a 25-page booklet, "The Most Desirable Personal Characteristics," in which the data submitted by 1033 respondents are plotted in 15 bar charts and curves, and interpreted by the ECPD Subcommittee on Student Development.

Asked to list six carefully selected positive characteristics of human personality in the order of the most desirable, 80 percent of the executives gave first or second place to intelligence, thus rating it first among the desirable characteristics. Physical acceptability, defined as masculinity, good carriage, cleanliness, etc., was rated as least important, with 93 percent of the respondents giving this characteristic fifth or sixth place. Dependability was rated second among the most desirable characteristics; organizational acceptability as third; energy as fourth; and emotional acceptability as fifth.

Surprisingly enough, the returns for engineering school administrators, faculty, personnel officials, and even engineering students fell into the same order of importance as that charted by the executive group. In the case of students, a wider scattering of choice was indicated particularly in the end positions, where the more experienced respondents made decisive choices.

Another interesting result of the survey is the light it throws on the interpretation by the respondents of the meaning of the personal characteristics they were asked to rate. Six descriptive subheads were listed under each characteristic to clarify its meaning for those answering the questionnaire. For example, under the main characteristic, "intelligent," the following six subheads were listed: Clear thinking, reasonable; careful; imaginitive; shrewd; and adaptable. Respondents were asked to list the subheads in order of importance. The returns were revealing.

In general there was good agreement on what the main characteristics meant. For all respondents the intelligent man was, first, one who was clear thinking and, last, one who was shrewd. The dependable person was one who was truthful and not necessarily one who could get things done. Cooperativeness and consideration were rated the most important qualities of the organizationally acceptable man. But when it came to the term dynamic, divergence of choices indicated that no one was sure just what the term really meant.

The survey bears out the hypothesis advanced by the ECPD Subcommittee on Student Development that while human personality could not be easily defined, most people had a good idea of what were the most desirable of the personal characteristics, and that, in fact, these ideas or intuitions about human personality had assumed the aspect of group opinion.

Labor Department Pictures Outlook for Engineering Profession

Jobs in engineering—the Nation's third largest profession and one of its fastest growing—may increase by as many as 100,000 in the next 10 or 12 years to a total of roughly 450,000.

After the next few years, if engineering enrollments decline to levels suggested by past trends and if the oversupply of graduates is absorbed into other types of work, opportunities for new graduates will be considerably better.

Over the next decade engineering school facilities and instructional staffs should be provided to meet a demand for roughly twice as many graduates as were turned out annually in the prewar decade.

Salaries of younger engineers have increased relative to those of more experienced men in recent years. Earnings of beginning electrical engineers, for example, increased 66 percent from 1929 to 1946, those of engineers with 10 years of experience 22 percent and those of men with 25 years of experience 11 percent.

The greatest increase in earnings of engineers occurs in the first ten years of experience; after about 30 years of experience there tends to be a levelling off of average salaries.

Good training is increasingly important in the profession. Engineers with the master's degree earn, on the average, slightly more than those with the bachelor's but men with the doctor's degree earn considerably more than either of these groups.

The profession offers employment flexibility; between 1939 and 1946 more than 30 percent of the engineers changed employment location from one state to another, at least 25 percent changed their industry field, and from 8 to 14 percent of those employed in each of the major branches of the profession in 1939 had moved to another branch by 1946. Close relationship among the branches and similarity of basic training is also reflected in the fact that more than 20 percent of the engineers were educated in a branch of engineering other than that in which they were employed in 1946.

These are the main conclusions of a comprehensive study of the employment outlook for engineers recently completed by the bureau of labor statistics of the U. S. Department of Labor. The study—one of the bureau's occupational outlook series—will be published this Fall.—**American Engineer.**

Rail Haulage at Chino

by A. P. MORRIS

Open-pit mining has been in progress at Chino since 1910, and by the end of 1948, 128 million tons of ore and 180 million tons of waste had been removed from the pit by rail haulage. During 1948, 6,700,000 tons of ore and 6,900,000 tons of waste were removed from the pit by rail haulage. The present daily production hauled by rail averages approximately 22,000 tons of ore and 25,000 tons of waste, and this tonnage is moved by ten locomotives on the day shift, eleven on the afternoon shift, and ten on the night shift.

Beginning in 1940, steam haulage was replaced by electric. Power is generated at the company's power plant at Hurley, N. M., and transmitted at 24,000 volts. Direct current for locomotive haulage is supplied by a transformer and rectifier station located at the pit entrance. The 24,000-v current is transformed to 750-v a.c. which is converted to 750-v d.c. by three 1000-kw mercury-arc rectifiers. During the year 1948, the total ore and waste haulage amounted to 56 million ton miles, and the average power consumption was 0.2 kwhr per ton mile.

Locomotives—Ore and waste haulage is handled entirely by thirteen 85-ton straight electric locomotives operating on side-arm or overhead trolley. They were designed to haul a 600-ton load up a two percent grade at nine miles per hour. Our average loads are approximately 700 tons and the speed on maximum grades is about 8 mph. Each locomotive is equipped with four 250-hp traction motors, one for each set of wheels. The motors operate on 750-v d.c. There are three control positions: series for starting and slow speed, series parallel for intermediate speed, and parallel for full power and maximum speed. The locomotives are equipped with electrically driven compressors which supply air at 130 lb for operating brake equipment, side arm, and pantograph.

The locomotives run on side arms on active benches and on overhead on main lines and dumps. They are about forty ft long, and articulated as to front and rear trucks, so they can negotiate curves as sharp as forty degrees. Seven of them are equipped with cable reels which permit them to operate without trolley for distances up to 1000 ft. The use of cable is not satisfactory as the locomotives can only be operated in series, which limits the power and speed.

A train crew consists of a locomotive engineer and a brakeman. One electrician and helper on the day shift perform general maintenance and inspection. Contactors and controllers are the principal items of maintenance. One machinist and helper on the day shift devote their entire time to mechanical repair, and similar crews on the afternoon and night shift spend about half their time on mechanical repair.

Mr. Morris is a member of AIME and assistant mine superintendent for Kennecott Copper Corp. at Santa Rita, N. M.

Ore haulage—A train generally consists of seven cars, hauling ore an average of 4.15 miles (maximum 5.0 miles). Approximately 1650 tons of ore are hauled per ore locomotive-shift. Ore cars are delivered to a gathering yard of the A. T. & S. F. Railway Co. west of the pit, where they are combined into trains of forty cars and hauled by the Santa Fe nine miles downgrade to the mill at Hurley.

The A. T. & S. F. supplies 207 ore cars, 27 of 95 ton and 180 of 85 ton capacity. They are all metal, solid bottom, and weigh approximately 27 tons. They are equipped with hand brakes, and with empty and load air brakes, to give additional braking power on descending grades. The Santa Fe maintains and repairs the cars, but light repairs to damaged cars such as repairs to steps and grab irons, are made in our company shops.

Waste haulage—The average waste train consists of eight 30-yd or ten 20-yd side dump cars with a net load of approximately 420 tons and 350 tons respectively. The 30-yd cars weigh 34 tons and the 20-yd cars weigh 32½ tons. The average waste haul is 4.08 miles (maximum 7.06 miles), and approximately 1430 tons of waste are hauled per waste locomotive-shift. Waste is delivered to several dumps south and west of the pit.

Fifty 30-yd cars and fifty-eight 20-yd cars are used for waste haulage, the cars being steel side-dump type. They are equipped with two dump cylinders on each side for dumping on either side. Twelve 40-yd side-dump cars have been ordered to replace some of the 20-yd cars.

One waste train is brought in daily for servicing and repairs. Servicing consists of taking up piston travel, changing broken brake beams, checking air in dump and train lines, changing triple valves when necessary, and checking brasses and wedges, and packing journal boxes. There are six car repairmen

A recent view of the Kennecott Copper Corp.'s Chino mine at Santa Rita, New Mexico.

and seven helpers on day shift and one repairman and one helper on each the afternoon and night shifts.

Trackage—There are at present eleven operating benches served by rail haulage, ten being on the south and west sides of the pit between elevations 6250 and 5858 (the present bottom) and one bench on the east side of the pit at elevation 6500. Eventually benches will be established on the east side of the pit at 50-ft intervals below the 6500 level, and from the 6250 level on down they will tie in with existing benches. It is expected that the pit eventually will reach an elevation of 5600. Benches below elevation 6200 are reached by a switchback system of double track on the north side of the pit. Ore and waste haulage diverges on the west end of the switchbacks at elevation 6230, the ore going downgrade to the Santa Fe yard, elevation 6175, and the waste continuing upgrade to dumps at a maximum elevation of 6415.

There are approximately 39 miles of standard gauge railroad track in service, most of which is electrified. We have standardized on two rail sections, 90 lb for operating benches and dumps and 132 lb for main line tracks in the switchback system. Switchback maximum grades are 2.1 percent, compensated 0.04 percent per degree of curvature. Maximum main line curves are eighteen degrees.

Operating bench tracks are made of 33 and 39-ft movable sections which are shifted by bulldozers equipped with booms. Grades for track shifts are prepared by bulldozers and a carryall. Steel towers and steel poles with concrete bases support side-arm trolley used on operating benches, and the towers and poles are shifted by a bulldozer equipped with a long boom. Trolley is strung and lined by tower cars. Dump tracks are made of nonsectionalized track and are also shifted by bulldozers. Fabricated steel poles support overhead dump trolley and are bolted to long switch ties which are shifted with the dump track.

There are approximately 110 men engaged in laying and maintaining tracks. The electrical department has a trolley maintenance crew of fifteen men who spend about eighteen percent of their time on pit and dump trolley work. There are two men who work on bonding and cutting rail.

Equipment used in track construction and maintenance consists of one steam 87-ton locomotive used for switching, one 120-ton steam hoist, one 50-ton steam hoist (one 50-ton Diesel-electric hoist is on order), two gasoline-driven track compressors together with miscellaneous pneumatic track tools, one gasoline powered trackshifter, one gasoline-powered tool car, two spreaders and seven flat cars. Ten D-8 bulldozers are available for track work.

Two gasoline-powered tower cars, one construction car (not self-propelled), one gasoline-powered bonding car and one bulldozer crane are used for trolley construction and maintenance.

Dispatching—A central lookout station on the north rim of the pit manned by an experienced trainman on each shift directs the movement of all rail traffic at the mine. It is connected by phone with thirteen switch locations manned by switch-tenders. Two-way radio communication between the central lookout station and all pit foremen's trucks does much to facilitate the entire pit operation. At present one locomotive is equipped with radio and it is expected that all locomotives eventually will be so equipped.

Future plans—The switchback system as originally laid out provides an entrance to one end of each operating bench. This necessitates maintaining passing tracks in order to minimize train delays. The ideal condition is to have both ends of each operating bench connected with the switchbacks to permit through traffic, and connections are being made as rapidly as operating conditions permit.

As the pit is deepened and the length of haul increases, it probably will be necessary to increase the number of locomotives to haul a given tonnage. A study is being made of the possibility of hauling longer trains with heavier locomotives or operating our present locomotives in tandem.

We are also investigating the possibility of installing centralized traffic control, consisting of an automatic electric-block system with power-operated switches controlled from a central station, thus eliminating the necessity of manning many of the present switches.

South African Diary

by J. G. EVANS

It is with a certain amount of trepidation that a man considers gathering his family of six, traveling across a continent, two oceans and a sea, and going to live in a foreign land. But "pioneering" is still possible, and a nation is "foreign" only until one has lived in it. We've had eight years of pleasant experiences in South Africa on which to base that contention.

It was in January 1938 that my brother first extolled the virtues of South Africa to us, and just three months and a thousand small problems later my wife, two daughters, three sons and I were boarding a ship in New York, bound for Capetown. We arrived in May, and within a week had found a furnished home with beautiful lawns, tennis court, a garden, and everything needed for family comfort. The children were soon located in school, and I settled down to the task of entering the importing business, as had been my original intention.

The importing business started out slowly but was coming along nicely when on Sept. 3, 1939 the war started in Europe and a declaration of war by the Union of South Africa was made on the following day. With the declaration came import and export controls. In fact we were controlled completely out of business in one stroke. Liquidating the business, I went to Johannesburg intending to find work in one of the mines. Government health and safety regulations require that all underground mine employes have a red ticket from the Miners Phthisis Bureau certifying that they are not susceptible to silicosis, the scourge of the Witwatersrand gold mining industry. I made application to the Bureau, completed a form covering my whole past life, and was given a complete physical examination. The following day I was startled to find that I had not only been refused a red ticket but had been classified with a green ticket which forever bars one from working underground in any scheduled mine in the country, and all this in spite of my apparent perfect health. This was hitting below the belt, but appeal was useless—the Bureau was supreme. Later, I found that less than half a dozen American engineers are to be found in the entire district.

However, I was successful in landing a job as draftsman and works manager for the Main Reef Engineering Co., owned by C. H. Funkey, formerly of the Michigan iron range, who had come to South Africa for the Sullivan Machinery Co. and had later gone into business for himself. During the year I was with Mr. Funkey, we built the first Diesel locomotive used underground in the Witwatersrand gold mines and also built hoists and loaders using air motors as prime movers. In October 1940, A. W. Dale, South African manager for the Gardner-Denver Co., offered me a job as field engineer covering the Union of South Africa and old German Southwest Africa. This offer was for more money than I was getting, and afforded travel opportunities, so I resigned from the Main Reef Engineering Co. and joined Gardner-Denver. In December 1939 my family joined me in Johannesburg where we found a house in the suburbs of Kensington. We started housekeeping once again, aided by our native servant John Moche.

Mr. Evans is presently employed by the Gardner-Denver Co. at Kansas City, Mo.

John came to us from the Orange Free State. He had attended a mission school and could speak, read, and write three languages. The average wage paid servants, in addition to board and room with some castoff clothing, was about twelve dollars per month. All natives coming into town for work have to obtain passes from the Native Affairs Commission. On employment, the employer takes up the pass and has it registered at the nearby pass office. He must also put a shilling stamp on it every month when he reports the continued employment of the native. All contracts of domestic servants run month to month and thirty-day notice on either part must be given to terminate the employment. Three weeks paid vacation per year is a requirement as well as one day off a week. No native can leave his job after dark without the written permission of his employer, or verbal permission before dark. His evening pass must state where he is

going and when he must return. Frequently the police patrol will stop a native on the street at night and demand his pass. If he has none, or is out after the time specified on the pass, he is arrested, and if convicted he may be sent to jail for sixty or ninety days hard labor. John remained with us for five years. He did all the housework, polished the shoes left by the bathroom door every night, kept the car looking like new, mowed the lawns, took care of the garden, and even did some of the cooking when my wife would allow it.

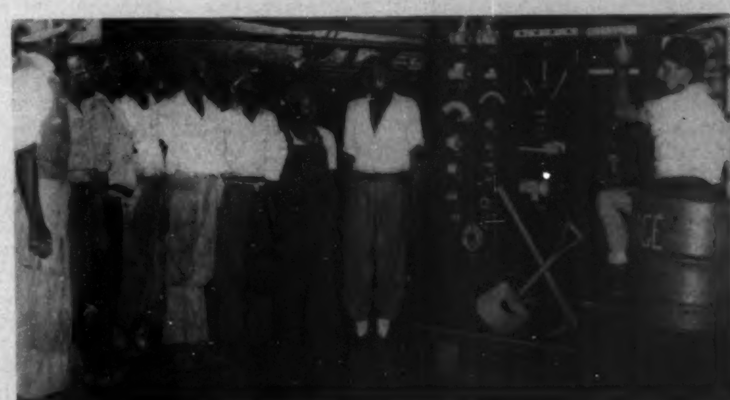
Living costs in South Africa are very near those found in the average American city of around 250,000 to 500,000 population. House rents vary from $35 to $150 per month, depending upon the type of house and the location. Clothing costs average nearly the same as found in the States. Food costs are the same with the exception of vegetables and fruits in their season which we sometimes found to be cheap; particularly semi-tropical fruits such as pawpaws and avocado pears which normally are considered a luxury in the United States. Automobiles are about 25 percent above the price for similar cars in America. Gasoline, which is sold by the imperial gallon, averages about the same price as an imperial gallon in Canada—roughly thirty to forty cents per gallon. Lubricating oil is a little higher, averaging about fifty cents per quart. Utilities such as water, electricity, and telephone service compare with charges made in the United States. Entertainments such as theaters, etc., are also the same as for a city of similar size in the United States. Railroad fares are, in most cases, slightly lower except for the extra-fare trains running between Johannesburg, Capetown, and Durban where travel is slightly higher. Air travel is also higher than in the United States.

Johannesburg, the City of Gold, had its beginning in September 1886 when a small group of pioneers numbering two or three score listened to the official proclamation of the Witwatersrand gold field. In less than ten years Johannesburg had over 100,000 inhabitants, black and white. The city has since grown to about 766,000 and the whole Witwatersrand district has a population of over 1,400,000. Today, half of the population of the Union of South Africa obtains its livelihood directly or indirectly from the gold mining industry, and half of the government finances are derived from this source. South Africa's transport system, representing some 13,483 miles of 3 ft 6 in. gauge rail lines and 21,712 miles of road motor-truck service, has Johannesburg as its hub. No private trucking companies are allowed to operate in South Africa as they do in the U. S. In spite of this complete government monopoly of transportation freight rates are low, especially on farm products, and the major highways are always in good condition considering that a large part of them are still gravel. Johannesburg, in addition to being the seat of the greatest gold mining industry in the world, having produced to date nearly 25 percent of the known metal in existance valued at over nine billion dollars at the present rate of exchange, is the center of manufacturing and industry for the Union; has the most dense white population in all Africa; and is the financial and trading center of the area south of the Belgian Congo. The Witwatersrand University has an enrollment of over 4000 students, and Johannesburg is one of the most prosperous cities in the world. All modern conveniences are in abundance.

The climate of this City of Gold is exceptionally fine, the average annual temperature being about sixty degrees. I have seen a slight skiff of snow early in the morning during August or September, however it lasted but a few minutes in spite of the city's elevation of about 6000 ft which is roughly the same as Butte, Mont. The Tropic of Capricorn lies about 250 miles north of the city.

Considerable criticism has been leveled against South Africa for operating the gold mines at full production during the War, but if the facts were fully understood no comments would be forthcoming, as the entire economy of this country is built on gold and gold mining. Thus, it was absolutely necessary that the gold mines keep operating to provide the finances required for the full operation of South Africa's war effort. Reduction in white labor was made wherever possible and increased production per man soon manifested itself as a wartime effort.

Some comments have recently been made concerning the poor conditions under which the native mine worker is forced to live and work in the Witwatersrand gold fields. Speaking from nearly seven



Sturdy African natives are taught the use of mining tools before they enter the South African Development Corp.'s iron mine at Thabazimbi.

At left, fit for a king, the spotless, comfortable native huts in a labor compound at a Rand gold mine. Below, a queen mother's kraal in Swaziland.

years of first-hand contact with all of the gold mines in the district as well as every base metal mine from Cape Town to Grootfontain in old German Southwest Africa, including the 3000 natives working in the Kimberley diamond mines, I have yet to see any mine natives being forced to live as poorly as the natives do at home in their own kraals. Food is more than adequate. They come into the kitchens with a basin the size of our hand wash basins. The chef serves the meal (white corn meal—the natives will not eat yellow meal) with a short-handled shovel. Each boy gets all he wants, as many shovelfuls as he can eat. He then gets meat, beans or cooked peanuts, and sometimes vegetables. The diet is prescribed by the government. Sleeping quarters are also regulated by law. Mine safety is higher than anywhere in the world, in spite of the fact that the average native never saw a mine or machinery of the kind in his life, has little or no schooling, and must learn the kitchen or mine Kaffir language spoken by all mine employes both white and black.

Benefits to the native and his family back in his kraal are many. Sanitation and first aid soon become a part of every native's life. Regular medical examinations for silicosis let him know what doctors can do for him. Thrift is established through his learning to send part of his earnings home to his wife, mother, or father by means of the post office money order department. Money can be sent by this method to all parts of the country or to the most remote native village out in Nyasaland, Portugese East Africa, the native territory, Angola, or the Rhodesias.

The average value of ore mined in these mines runs about seven dollars per ton. Careful and efficient mining methods are a must even with cheap labor averaging about 35 cents per shift plus food and lodging. The cyanide process is used exclusively in gold recovery, the ore being reduced to minus 200 mesh before being treated. Average recovery is high with this fine grinding. Increased cost of supplies, taxes, and ultra-deep mining down in some mines to 9000 ft where rock temperatures

reach over 105F have brought about real problems of keeping out of the red. However, to date, only two mines have reached the end of economic production.

Thirty-six miles to the north of Johannesburg, along a beautiful tree-lined boulevard, lies Pretoria, seat and administrative capital of the Union, and former home of Paul Kruger or Oom Paul (meaning Uncle Paul) as he was generally known. He was the president of the South African Republic at the time of the Boer war. In passing, I can not refrain from mentioning one of the Solomon-like decisions this illiterate man of wisdom made during his term as president, which is recalled in Marjorie Juta's delightful book the "Pace of the Ox." A man handed over 100 golden sovereigns to a hotel proprietor for safe keeping. Later on the proprietor denied having received the money, and so the trusting fellow appealed to Oom Paul. "What am I to do, President? My money has been stolen." Kruger's reply was as follows: "Take another hundred sovereigns and in the presence of two witnesses ask him to put it in the safe for you. Go later alone and ask him for it; he will give it to you because he knows you have witnesses. The next day go with your two witnesses and ask him

Workers and their families receive modern medical care at the mines, under company and governmental surveillance, but . . .

. . . conditions back home are unsanitary and changeless.

for the hundred sovereigns they saw you hand him."

Oom Paul's reference to the intrusion of the British into his country in the following words indicates his lack of hatred even under the most trying conditions. "In the meantime we can always cooperate in love and peace, and where we differ we can always argue with each other in brotherly love."

The steel industry of South Africa had its beginning in Pretoria. Coal and coke from the fields to the east and the finest iron ore in the world from Thabazimbi, less than 100 miles to the north, make a perfect combination. At present the steel industry is producing over 40,000 tons per month and further expansion is under way both for the production of raw steel as well as for the secondary industries, such as farm implements and railway equipment. South Africa is rich in all base metals save lead and zinc. There is tin, copper, tungsten, manganese, chrome, vanadium, antimony, mercury, and asbestos, along with the world's largest diamond and corundum deposits.

The war years of 1939 to 1945 saw this little country get solidly behind the production of needed metals whenever possible. On a leave of absence from my work, beginning in October 1942 and on into April 1944, I was manager of one of the government-sponsored tungsten mines operated entirely as a war measure. September 1943 saw over 100 tons of tungsten concentrate, averaging over 65 percent, leave these scattered workings for overseas. Living in tents, hauling water, no medical care closer than 150 miles except for a monthly visit from the district doctor, and depending on only the Bushmen and Hottentot for labor, it was quite an experience indeed. Again in January 1945, I was called by my own Uncle Sam to take charge of the first commercial corundum mine in the Union. Bausch & Lomb were losing some 65 percent of their lenses due to defects caused in grinding with synthetic abrasives while with corundum this loss was cut to under ten percent. The alluvial deposits of corundum in the northern Transvaal have produced some 80,000 tons of corundum during the past 35 years—all picked up by natives and sold to outlying trading stores, later sent to a central buyer in Petersburg, and then to the American Abrasive Co. in the States. Our Transvaal mine operation relieved the shortage and thus materially assisted with the war effort. Following the loss of the Narvick iron ore in Norway and long after lend lease had taken over, the South African Iron and Steel Company's mine at Thabazimbi shipped 1000 tons of their best ore to Great Britain in addition to supplying their own blast furnaces which were working under a 24 hour, seven-day week schedule. Thousands of tons of copper, chrome and manganese as well as large quantities of industrial diamonds poured into the hands of the allies as South Africa's part of the war effort.

Business opportunities for Americans in South Africa are good especially in the fields of equipment supplies for the mines and heavy equipment for the railroads and national roads. The abundance of mineral resources also offers many opportunities, and the South African government is most interested in the development of these resources and will assist in every possible way to bring about a successful mining operation. A good example of the investment possibilities for large companies is indicated in the success of the Newmont Mining Company's ventures at O'Okiep in Namaqualand, South Africa, and at Tsumeb in old German Southwest Africa.

For the mining engineer who is seeking employment, I would suggest that he make connection with some American company with an established branch in South Africa where they can send him direct from this country rather than to go there with expectations of finding employment after he arrives. Conditions in South Africa are quite different from those found here at home, and if a person were to go there without connections and not acquainted with the way of life of that country, he would find it most difficult to find employment. This is especially true if the engineer is trying to find work in one of the mines, as my experience will bear out.

The UN Resource Conference

by Julian W. Feiss

Trygve Lie, Secretary-General of the United Nations, has pointed out that the U. N. Scientific Conference on the Conservation and Utilization of Resources was the first step taken by that body toward mobilizing world science and technology to promote higher standards of living.

Whether or not the Lake Success conference, which ended on Sept. 6, can be considered as a successful effort will depend essentially upon the use to which its deliberations are put. It is understood that complete transactions of the conference will be published before the end of the year. If these transactions are studied in the chanceries of all nations represented—approximately fifty countries sent participants and observers—the conference may mark a turning point in man's attempts to achieve lasting benefits through science and technology.

The conference made no recommendations and did not function as a policymaking group. Those who participated in the meetings (the USSR was not represented) were not official representatives of any nation. They had no power to bind their governments nor to formulate recommendations to the United Nations. The conference did not attempt to reach international agreements and, as the Economic and Social Council of the United Nations made clear at its sixth session, the tasks of the conference were primarily "to be limited to the exchange of experience on the techniques of the conservation and utilization of resources." Had the mission of those who attended been otherwise, it is possible that the meeting would have degenerated into a debating society wherein hours would have been spent arguing over details which in the end would be of relatively little importance to the world at large.

Mr. Feiss is an AIME member and assistant to the director, U. S. Bureau of Mines.

The portion of the conference that dealt with minerals conservation embraced to a greater or lesser degree every phase of technologic endeavor as applied to geology and resource appraisal, mining, metallurgy, processing, utilization, and salvage.

The problems of mineral conservation fall within these categories, but, as one might anticipate, a major portion of the discussion at the conference centered about the first point—the problems of mineral resource appraisal and the estimates of future demand. It became evident as the conference progressed that little knowledge is available about mineral reserves on a world-wide scale. Generally, it was felt that there would be ample supplies of mineral commodities for all, providing means of distribution could be made more efficient, assuming that wars would not again disrupt human progress, and, lastly, assuming that population trends did not increase beyond reasonable expectancy. However, there was no unanimity on the question of mineral and fuel reserves. A. I. Levorsen, dean of the School of Mineral Sciences at Stanford University, reported an estimate of possible world petroleum reserves at the plenary session of August 22. Dean Levorsen's estimates were immediately challenged by M. King Hubbert, associate director of the exploration and production research division of the Shell Oil Co. As a result of the ensuing discussion, a separate session was held during which an attempt was made to re-examine in an impartial manner the question of the world's petroleum potential in the light of knowledge currently available. This controversial question, highlighted by the specific discussions at the conference, indicated beyond all shadow of a doubt that one of the most important problems in respect to minerals conservation is that of proper appraisal on a world-wide scale. The need for efficient geological surveys in all parts of the world was obvious, and one of the lessons that the conference drove home was the necessity for more attention to the problems of fundamental geology as applied to mineral resource appraisal.

Undoubtedly we are too close to the conference to be able to judge its results. Furthermore, those who participated were able to view only a small portion of the program which was conceived on a tremendously comprehensive scale. Some pessimism has already been expressed and, in the August 25 issue of the "Manchester Guardian Weekly," an article by Alistair Cooke, entitled "Frustrated Successes by UN," makes the following statement at one place in the text: "Every time a distinguished scientific body meets at Lake Success, it shows at once its capacity to understand the roots of profound and practical policies. But it immedately becomes aware of trespassing on the functions of the Security Council and the Assembly. And so, with a sigh and yet another warning, it passes on to the discoveries that vitiate the work of those superior bodies."

Fortunately, I think that the majority who participated at Lake Success would disagree with this statement. The conference proved that scientific and technological men can sit around a table and discuss impartially world problems without resorting to blows or to the necessity of political proselyting. More important, the mere fact that this conference was held indicates that those within the United Nations who are seriously attempting to guide the destiny of the organization recognize that an effort must be made to call upon the impartial men of science and engineering to make their contribution to the welfare of mankind. The responsibility for world peace, and for problems involving international politics, may not rest upon the shoulders of the scientist, but there is general recognition that the time has come for him to enter the arena. If the civilization that we know is destined to survive, and to progress, the scientist, the engineer (and among them are many of our ablest thinkers) must be willing to put their talents to work for the benefit of all mankind.

AIME-ASME Fuels Conference

The Twelfth Annual Joint Conference of the Coal Division, AIME, and the ASME Fuels Division, will be held at the French Lick Springs Hotel, French Lick, Ind., on Wednesday and Thursday, Oct. 26 and 27. The Indiana Coal Preparation and Utilization Society will join the gathering in lieu of their Annual Coal Conference which is usually held each fall. R. H. Swallow and John R. Michel are General Chairman and Co-Chairman, respectively, of the meeting. Eight technical papers will be presented at three technical sessions. Two luncheons, a banquet, and an all-day field trip are also on the agenda. Philip Willkie, member of the Indiana General Assembly and son of the late Wendell Willkie, will address the Wednesday evening banquet.

The Conference is held to develop a better understanding of the interlocking problems of the coal producers and the coal consumers. The first meeting took place in Pittsburgh in 1937, and since then eleven other meetings have been held, in as many cities, with attendance as high as 500.

Program

Wednesday, Oct. 26

Registration. 9 a.m. Conference fee for members and guests, $6.50.

Welcoming Address. 9.30 a.m., by E. R. Price, Chairman, Coal Division, AIME.

Technical Session. Symposium on Dewatering and Drying Coal. W. L. McMorris, Jr., Chairman; Ray G. Baughman, Vice-Chairman.

Moisture Control with Flash Dryers, by F. P. Calhoun.

Operating Data for a Verti-Vane Thermal Coal Dryer, by Orville R. Lyons.

Coal Drying in Relation to Coal Preparation, by John L. Erisman.

Luncheon. 12.15 p.m. Max A. Matthews, Chairman. Ward F. Davidson will speak on "Some Design Problems of Nuclear Power Plants."

Technical Session. 2 p.m., Convention Hall. John R. Michel, Chairman; George W. Land, Vice-Chairman.

Steam Generator Design Development as Influenced by Available Fuels and Fuel Quality, by John Van Brunt.

Fuel Burning Equipment Development for Available Gas, Oil and Solid Fuels, by R. K. Allen.

Executive Committee Meetings. AIME Coal Division, ASME Fuels Division. 4 p.m.

Banquet. 7 p.m. Preceded by cocktail hour at 6:15. M. M. Leighton, Toastmaster; Philip Willkie, Speaker.

Thursday, Oct. 27

Registration, 8:30 a.m.

Technical Session, 9 a.m. C. A. Reed, Chairman; Orville R. Lyons, Vice-Chairman.

Some Factors Influencing the Froth Flotation of Coarse Coal Particles, by Shiou-Chuan Sun and R. E. Zimmerman.

Laboratory Control in Coal Washing and Drying Plants, by J. J. Merle and R. A. Mullins.

The Use of Ignition Baffles with Single Retort Stokers, by T. S. Spicer, R. J. Grace, and C. C. Wright.

Luncheon, 12:30 p.m.

Inspection Trip, 11 a.m., at Central Indiana Coal Co.'s Maid Marian Coal Mine. Lunch to be served en route.

Ladies' Program

Wednesday

9 a.m.—Registration.
10 a.m.—Visit to French Lick Springs Hotel Gardens.
12:15 p.m.—All-Conference luncheon.
2 p.m.—Bridge—Tea.
6:15 p.m.—Cocktail hour.
7 p.m.—All-Conference dinner.
9 p.m.—Dancing.

Thursday

9 a.m.—Bus trip to Spring Mill State Park.
12:30 p.m.—All-Conference luncheon.

Mining Programs for All-Division LS Meetings

Mining programs for the all-division Pittsburgh and Southern California Local Sections meetings follow. Further information about these meetings, mentioning other participating divisions and social affairs, may be found on page 53 of AIME News.

Pittsburgh, William Penn Hotel, Oct. 28:

Performance of Russelton Cleaning Plant with Full-Seam Mining of Thick Vein Freeport Coal, J. S. Neill, Prod. Eng., Republic Steel Corp.

Economics of Large Diameter Ventilating Boreholes in Coal Mines, Raymond Mancha, Vice President of Ventilation, Joy Manufacturing Co.

The Analysis for a Continuous Mining Machine, Gerald Von Stroh, Bituminous Coal Research Mining Development Committee.

Symposium on Roof Bolting—Methods and Results, W. G. Cooper, Coal Mine Inspector, U. S. Bureau of Mines; J. J. Raves, Supt., Pittsburgh Coal Co.; Lee Siniff, Consolidation Coal Co., Kentucky.

Los Angeles, Elks' Club, Oct. 21:

A Review of Recent Industrial Minerals Developments in the Columbia River Basin. By A. O. Bartell, Managing Engineer, Raw Materials Survey.

The Asbestos Industry in South Africa. By Paul Klempner, Consulting Engineer, Johannesburg, South Africa.

Pyrophyllite. By J. F. Lance, Professor of Geology, Whittier College.

The Recent Calaveras Cement Company Dust Suit. By Wm. Wallace Mein, Jr.

Geochemical and Geobotanical Prospecting for Barium. By E. E. Roberts, Dept. of Geology, Stanford University.

Trends in the Precious Stone Industry. By R. M. Shipley, Jr., formerly Director of Education and Research, Gemological Institute of America.

Potash Mining and Refining in Southeastern New Mexico. (Illustrated by colored motion pictures.) By J. P. Smith, Chief Geologist, U. S. Potash Co., Inc.

Gypsite in the San Joaquin Valley, California. By Wm. Ver Planck, California State Division of Mines.

IMD to Meet in Tampa

The Industrial Minerals Division, AIME, will hold a four-day meeting at the Tampa Terrace Hotel in Tampa, Fla., beginning Tuesday morning, Nov. 8, and ending Saturday morning, Nov. 12. Sixteen technical papers will be presented at four sessions on Wednesday and Thursday and then all day Friday and part of Saturday will be devoted to field trips. Advance registration will be on Tuesday morning, and will continue through Wednesday. James B. Cathcart of the U. S. Geological Survey is Chairman of the local program committee for the meeting.

Social events: There will be a Division luncheon on Wednesday, and Thursday's feature is a banquet at 8:00 p.m., to be preceded by a cocktail hour. For the sport-minded, a football game between the Univ. of Florida and the Univ. of Kentucky is scheduled for Saturday night. The committee on Ladies Entertainment is planning several trips to points of interest in the area, as well as bridge games, golf, and fishing.

Program

Wednesday, Nov. 9

Technical Session, 10 a.m.-12 m. I. M. LeBaron and H. A. Meyerhoff, Associate Chairmen.

Résumé of the Geology of Florida. By R. O. Vernon, Florida Geol. Survey.

The Development of Florida's Mineral Industry. By J. L. Calver, Florida Geol. Survey.

Phosphate Mining in Florida. By R. B. Fuller, International Mineral and Chemical Corporation.

Technical Session, 2-5 p.m. J. B. Cathcart and R. M. Foose, Associate Chairmen.

Use of Isopachous Maps in the Florida Phosphate District. By Stuart W. Maher and Thomas E. Wayland, U. S. Geological Survey.

Cyclones for Desliming and Dewatering in the Land Pebble Phosphate Field. By Hugh Wright.

Processing of Phosphate Slimes for the Production of Lightweight Aggregate and Insulating Material. By Poole Maynard, Atlantic Coast Line R. R.

Effect of Waste Disposal of the Pebble Phosphate Rock Industry in Florida on Condition of Receiving Streams. By R. C. Specht, University of Florida Experiment Station.

Thursday, Nov. 10

Technical Session, 9 a.m.-12 m. A. S. Furcron and Thomas Kesler, Associate Chairmen.

Talc Industry of Western North Carolina. By E. C. VanHorn, Tennessee Valley Authority.

Crab Orchard Sandstone of Tennessee. By Benjamin Guildersleeve, Tennessee Valley Authority.

Kaolin Mining and Treatment in the South. By Paul M. Tyler, Consulting Mineral Technologist.

Technical Aspects of High Tension Separation. By J. Hall Carpenter, The Humphreys Investment Co.

2-5 p.m. Hugh D. Pallister and Frank R. Hunter, Associate Chairmen.

Fluoride in Groundwater of Alabama. By Philip E. LaMoreaux, U. S. Geological Survey.

Economic Aspects of Groundwater in Florida. By V. T. Stringfield and H. H. Cooper, Jr., U. S. Geological Survey.

Some Properties of Psuedo-wavellite from Florida. By W. L. Hill and W. H. Armiger, U. S. Department of Agriculture.

Potential By-product Elements in the Phosphoria Formation of the Western States. By V. E. McKelvey, U. S. Geological Survey.

Friday, Nov. 11

Field trips to phosphate area. The group will be divided into two parties, one to visit Noralyn mine and plant of International Mineral and Chemical Corp. in the morning and the Bonney Lake Table Plant and Wet Storage of the Davison Chemical Corp. and the Belt Flotation of the Coronet Phosphate Co. in the afternoon. The second party will reverse the itinerary, both parties to meet for lunch at the Bonney Recreation area.

Saturday, Nov. 12

Morning field trips. There are three alternatives: (1) One party will visit the heavy mineral operation of the DuPont and Humphreys Corporations; (2) another will visit the Camp Concrete Rock Co. limestone quarry at Brooksville, Florida, and (3) a third party will visit any of the plants or mines in the land pebble area.

AIME NEWS

Southern California Section Fall Meeting

All divisions of the Southern California Section, including metals, mining and milling, industrial minerals, and petroleum, will participate in the fall meeting on Oct. 20 and 21. Los Angeles, of course, is the host town; metals division meetings are to be held at the new Institute of Aeronautical Science building, while the petroleum, industrial minerals, and mining and milling division meetings will be at the Elk's Club.

Two full days of technical sessions are scheduled for the petroleum group by general chairman John T. Thatcher, Jr. Thursday, the Town House will be host for the oil men's luncheon.

This year the industrial minerals, and mining and milling divisions will join together for a two-day session. Ian Campbell and George Dub have planned for numerous papers by good men on interesting subjects.

Four papers are listed for the metals division on Thursday afternoon and evening, with the meeting taking the form of a symposium on creep of metals. Fred Boericke is chairman.

The annual all-division luncheon of the Section will be on Oct. 21 at the Town House. In addition to other business, Student Awards will be presented.

The men responsible for the programs have spent a lot of time getting them ready for you so that you will be assured of an interesting and profitable time.

Walter Hull Aldridge, John Fritz Medalist for 1949

Announcement has just been made by the John Fritz Medal Board of Award of the award of the John Fritz Medal for 1949 to Walter Hull Aldridge, president of the Texas Gulf Sulphur Co., and recipient of the AIME Saunders Mining Medal in 1933. This board of award is composed of four representatives, all past presidents, from each of the four Founder Engineering Societies. The medal is called the "medal for medalists," regarded as the highest honor an engineer may attain.

Further details regarding the career and professional achievements of the Medalist will be published in a forthcoming issue of the journals.

The citation reads:

"WALTER HULL ALDRIDGE

As Engineer of Mines and Statesman of Industry who by his rare technical and administrative skills has importantly augmented the mineral production of our country and Canada, and who by giving unselfishly of his wisdom and vision has guided his professional colleagues to higher achievements."

AIME and ASME Joint Meeting

The final draft of the program for the twelfth joint meeting of the Coal Division, AIME, and the Fuels Division, ASME, to be held at French Lick Springs Hotel, Oct. 26 and 27, has been completed. It looks like a program which fuels men can't afford to miss. For a list of papers see page 51 of *Mining Engineering*. The banquet speaker is to be Philip Willkie, son of the late Wendell Willkie. A program is being prepared for the ladies which will include a visit to the French Lick Springs Hotel gardens, bridge, dancing, and a bus trip to the nearby Indiana State Park limestone cave.

Get on the ball, you fuels men, and your ladies; get your facts and fun at French Lick.

Pittsburgh Section Off-the-Record Meeting

The Pittsburgh Section has gone all-out to plan its Oct. 28 meeting to interest coal, petroleum, open-hearth, and metals men. Programs for each group are listed in the related journal but get to the meeting if you can possibly make it. You'll find it worthwhile.

The Coal Division sessions will be held in the Pittsburgh Room of the William Penn Hotel; all other sessions will be on the 17th floor. There will be a luncheon and dinner and at the latter, two special motion pictures will be shown, the first on air-borne missiles, and the second on the defense of Antwerp during the Battle of the Bulge.

Industrial Minerals Division Meets in Tampa

Tuesday, Nov. 8, is registration day for the annual fall regional meeting of the Industrial Minerals Division; the Tampa Terrace Hotel, needless to say in Tampa, Fla., will be headquarters from Nov. 8 to 12. Two days of technical sessions are scheduled for Wednesday and Thursday featuring papers on geology, mining, and milling of Florida phosphates and other mineral resources, and papers on industrial minerals in the southeastern states. A cocktail party and banquet wind up Thursday's affairs, but be up for the field trips on Friday and Saturday to a limestone quarry, a heavy mineral operation, and the phosphate producing areas. If you want to stay over Saturday evening, there's the University of Florida-University of Kentucky football game.

THE DRIFT OF THINGS

. . . as followed by EDWARD H. ROBIE

1950 Dues Bills

To expedite the recording and acknowledgment of remittances, the plan of staggering the mailing of dues notices is being continued this year. First to be sent out have been the bills to our members outside of the U. S. A., for these will require more time in transit, and often delay is incurred in securing American dollars. Mailing of all bills will be completed in late December. It is hoped that members will respond as promptly as they can, although dues do not actually become payable until January first.

Those who have found the dues bill more or less complicated in previous years will, we hope, find the current statement simpler and more acceptable. It is predicated on the assumption that a member will wish the same Branch journal or journals in 1950 that he has been receiving in the past. If he wishes to change his selection he should so state on the bill and correct it accordingly. Members are entitled to receive free, as part consideration for their dues, a 1950 subscription to one of the following: **Mining Engineering, Journal of Metals, or Journal of Petroleum Technology.** If two different journals are desired the additional charge is $4, or if all three are wanted the added charge is $8. Additional subscriptions to the same journal must be paid for at the nonmember price—$8 each for the Americas and $9 foreign.

The technical papers published by each of the three Branches of the Institute appear monthly in the respective journals. Enough extra copies of these technical papers are printed each month so that they can be bound together at the end of the year into Transactions volumes, supplied at cost to those who wish to have them. Such bound copies for members' libraries preserve a complete file, in permanent form, of the technical publications of the respective Branches of the Institute. Although one may try to keep individual copies of the journals, often one or more will become lost.

These three Transactions volumes will be published in January of each year, each containing all the technical papers, discussion, and an index, published by the respective Branches in the previous year, and nothing else. Members that have already requested one or more of these volumes to be published next January will find the appropriate charge therefor on their bills. Those that did not so specify on their publication selection slips last year, but now wish to have one, should add the item to their bill and enclose an additional $3.50 for each volume selected; so long as our limited supply lasts they will be accommodated.

We shall assume that members will wish to receive, early in 1951, the same bound volume or volumes, if any, that were selected in 1950 and shall govern our overrun printing accordingly, unless we are advised to the contrary. The price of the 1951 volumes cannot be set until their cost is known but it should not be greatly different from the current price of $3.50.

No Institute Directory was published in 1949 but the usual volume will be prepared in the spring of 1950. Members that have not already advised Institute headquarters of any desired change in their listing should do so in the next few months, for no special canvass will be made for Directory purposes.

Bills will be sent out in duplicate, one copy to be returned to the AIME with remittance and the other to be retained for the member's record. If payment is made through a bank or agent, they should be sent both copies with the request that one be returned to the Institute, or at least they should advise us of the member's name and ledger number when making payment, so that proper credit may be accorded. The ledger number is the number that appears opposite the name on the address stencil.

Student Associates again in 1950 will have the privilege of selecting one of the Branch journals if they pay $4.50 dues. If they do not wish to have an annual subscription to a journal their dues are $2. They will be billed according to the amount they paid in 1949 but of course have the privilege of changing their classification for 1950 if they wish.

Mudd Volumes for Junior Members

For years, all Junior Members of the AIME, at the time they attain that status, have been given several volumes thought to be of interest to them, through the Seeley W. Mudd Memorial Fund. A dozen or more titles have been distributed in all. Currently each Junior Member is receiving a copy of the Institute's 75th Anniversary volume plus a copy of the new ECPD book, "A Professional Guide for Junior Engineers." Also, he is given the privilege of selecting, as a third volume, one of several books that

are in more limited supply and not of as wide professional interest.

The Mudd Fund Committee hopes, in the next year or so, to be able to supply books of special interest to young men in each of the ten Divisions of the Institute, as well as two or three volumes of general interest to all groups. Currently, for instance, no book is being offered of special interest to young petroleum engineers. Each Division is being asked to select the subject and potential author for such a book, and suggestions from the Junior Members themselves will be welcomed. The books should be concise and practical, preferably covering a subject of wide technical interest to Division members, and also preferably filling a gap in current technical literature. They may possibly take the form of a handbook. If they are of such a nature that they can be sold, to others than Junior Members who will get them free, so much the better for the Mudd Fund.

Steel and Coal

When this issue reaches its readers, they will know much more than we do now—on Sunday, Sept. 18th—whether or not a steel or coal strike is going on or is imminent. The report of President Truman's fact-finding board was a masterful compromise that satisfied neither side. Fortunately no general wage increase, for the steel or other industries, was recommended, and the amounts demanded for social insurance and pensions were reduced considerably below Mr. Murray's initial demands. The disagreement, bitter on both sides, is not on whether pensions are desirable — but whether workers should contribute to part of the cost.

The threatened coal strike has quite a different reason. The twenty-cent a ton royalty for miners' welfare seems never to have been adequate for the benefits paid, and certainly not after the three-day week reduced output from eleven to eight million tons. A group of Southern operators has refused to pay any royalty at all on coal mined since July 1, when the contract expired, the royalty agreement being a part of the contract. Mr. Lewis says this has made the miners boiling mad and they may quit work any time, which will mean still less money in the welfare fund.

To us, it seems unfortunate that social insurance and pensions ever should have become a matter for company-union negotiation. Had employers been more farsighted they would have urged more adequate payments under the Federal laws and thus perhaps have avoided individual company responsibilities in this regard. One bad feature of such plans from the economic standpoint, unless they are liberalized, is that they tie the employe to one company and thus do not promote a mobile labor supply in the country, a desirable factor for efficient production.

Sharing Our "Know How"

Point Four of President Truman's recommendations made to Congress last June has attracted considerable attention. It has to do with assistance to the peoples of economically undeveloped areas to raise their standards of living. The suggested aid falls into two categories: (1) technical, scientific, and managerial knowledge necessary to economic development; and (2) production goods — machinery and equipment — and financial assistance in the creation of productive enterprises. The President especially mentioned the fields of mining and metallurgy in referring to the need in underdeveloped countries for technicians and experts.

Assistance so far has been more in imparting American know-how to visitors from foreign countries than in sending American technologists abroad. More than 25,000 foreign students were enrolled in American universities in the college year just closed, and approximately 5100 of these were studying engineering. The ECA has just announced that fifty British engineers, with at least Master's degrees, will be brought to the United States this fall for one year of graduate training in practical applied science and technology, partly in schools and partly in plants. The cost will be about $3000 per man.

The Department of State hopes to send more technical men and teachers abroad in the future than in the past, but a start has already been made. For instance, George V. Allen, the State Department's Assistant Secretary for Public Affairs, who is intimately concerned with the project, recently cited the fact that two American mining engineers from the Bureau of Mines were now in Mexico assisting the Government in working out ore extraction processes. Also, many American geologists have been sent to Brazil in the last seven years to assist that country in locating and mapping its strategic minerals. The largest deposits of manganese in the Western Hemisphere have thus been discovered.

We feel that American firms in the mineral industry should cooperate to the fullest extent in these plans to promote world recovery, as many of them are now doing. Interested individual engineers should get in touch with the Department of State, Washington.

Arkansas Bonanza

Large mining companies have many offers of properties, and some of these offers are accompanied by reports that arouse the risibilities of the exploration engineers. Jack Baragwanath sends us a sample, a report of a mineral occurrence on a certain Arkansas farm which we will call the Smith farm, just to hide its identity and protect Freeport Sulphur from too much competition in securing an option:

"The starting point for the location of minerals is at the southeast corner of the Smith farm. The lead is located 1000 ft west of the said starting point and the vein runs thence northerly 1122 ft and averages 148 ft in width and about 25 ft thick. The ore is about 20-25 ft below the surface of the farm. The silver pocket is located 800 ft west of the starting point, thence north 300 ft to center of pour-out, thence north 200 ft to northerly edge of pocket. The pocket is 200 ft across at its widest part and about 38 ft thick. The ore is about 28 ft below the surface. There is a silver-copper vein about 15 ft wide through the pour-out at about 2000 ft down that runs the entire length of the Smith farm. The probable depth of the vein is about 1000 ft. [Then comes similar data about a copper pocket.]

"The Smith farm is one of the best that I have found in Ark. . . . There is a fortune in either of the three minerals. . . . The silver and copper were deposited in a molten form from a volcano and the lead was formed through filtration."

ITINERARY OF AIME SECRETARY

The Secretary of the Institute plans to be at the following places in the month of October:

Oct. 1. St. Louis and Rolla, Mo.
2. Baxter Springs, Kans.
3. Dallas
4. Austin
5-7. San Antonio (Petroleum Division)
8. Austin
10. Carlsbad, N. Mex.
11. El Paso
12. Silver City, N. Mex.
13. Morenci, Ariz.
14. Miami and Superior, Ariz.
15. Tucson
16. Tucson and Ajo, Ariz.
17. Ajo
18. La Jolla, Calif.
19-20. Los Angeles (Divisional Meeting)
21. Jerome, Ariz.
22. Albuquerque
24. Wichita
26. French Lick, Ind. (Fuels Conference)
27. La Fayette, Ind.
28. Chicago (ECPD Annual Meeting)

Mr. and Mrs. Robie are driving and are planning to visit as many Local Sections and Affiliated Student Societies as possible en route.

Fuels and Domestic Security

Fuels of the future, and their relationship to the domestic security of the United States will be discussed at the 29th annual meeting of the American Petroleum Institute in Chicago, Nov. 7 to 10. The fuels session will be held in the grand ballroom of the Stevens Hotel on Thursday morning, Nov. 10.

The forum will be opened with papers by W. M. Holaday of the Socony-Vacuum Oil Co., New York City, and W. G. Whitman of MIT. Holaday will discuss such questions as these: For maximum efficiency and conservation of our resources, should we use coal, liquid fuels, or gas? Which is best for power production, steam or internal combustion engines? What should be the fuel for steam power, coal, oil, or gas? What should be the fuel for internal combustion engines, Diesel fuel or gasoline?

Whitman will give his opinions on these questions: Who holds the responsibility for National Security? What about the fuel requirements for the next war?

Other Whitman questions revolve around these points: Timing of discovery and development—What is best for our country? Stockpiling versus imports—What should we do? Should we conserve our crude reserves and go the synthetic route, and if we do go the synthetic route what should we use in the production of synthetic fuels—gas, bunker oil, shale, or coal?

In Changing Your Address

When notifying AIME headquarters of a change of address, or of company position or affiliation, please mention the Branch of the Institute to which you belong—Mining, Metals, or Petroleum. This will make for a more expeditious handling of the change and will facilitate the preparation of various reports. A new Directory will be issued next spring; listings will be the same as in the 1948 Directory unless the Secretary's office has been notified of a change.

Gerow CIMM Secretary

Carlyle Gerow took office as secretary-treasurer of the Canadian Institute of Mining and Metallurgy

on Oct. 1. The AIME wishes him every success in his new post and anticipates a continuation of the fine fraternal spirit and co-operation that has characterized relations between our two institutes.

PRESIDENT YOUNG ON TOUR

President Young has already visited the Oklahoma City, El Paso Metals, Southwestern New Mexico, Carlsbad Potash and San Juan Sections of the AIME. Members in the following areas will have a chance to meet him as he continues his tour:

Oct. 1. Colorado School of Mines
4. Southeast Section, Birmingham
5. Univ. of Alabama, Tuscaloosa
6. Petroleum Branch, San Antonio
10. New Mexico School of Mines, Socorro
11. Colorado Section, Denver
12. Utah Section, Salt Lake City
14. Montana Section, Butte
14. Columbia Section, Wallace
15. Univ. of Idaho and Washington State Student Chapters, Moscow
17. North Pacific Section, Seattle
19. CIMM meeting, Vancouver
20-21. Southern California Section, Los Angeles
26. Coal Division, French Lick
27. Illinois Inst. of Tech., forenoon.
27. Univ. of Wisconsin, afternoon
28. Michigan College of Mines, Houghton
29. Upper Peninsula Section, Ishpeming

Nov. 7. Boston Section
8. Tri-State Section, Joplin (Tentative)
9. Kansas Section, Wichita
14. Arizona Section, Tucson
17. Lehigh Valley Section Luncheon (Tentative)

Dec. 7. New York Section
15. Coal Mining Institute, Pittsburgh

Jan. 9. Delta Section
10. Gulf Coast Section
11. North Texas Section
16. East Texas Section
(Above Jan. dates tentative)
19. Ohio Valley Section

Personals

John Eliot Allen has joined the department of geology at the New Mexico School of Mines, Socorro. He had been at Penn State.

J. W. Allingham, 509 7th St., Calumet, Mich., is a geologist with the U. S. Geological Survey.

H. I. Altshuler has left Peru, where he was general manager of the Vanadium Corp. of America, to take the post of general manager for Frontino Gold Mines Ltd. in Colombia, now under the technical direction of the Gold Fields American Development Co., of London and New York. Mr. Altshuler's new address is care of Frontino Gold Mines Ltd., Segovia Antioquia, via Otu, Colombia.

Robert B. Anderson is on a year's leave of absence from the Inland Steel Co. to get a degree in electrical engineering at VPI.

Robert H. Arndt is a professor in the department of geology at the University of Arkansas, Fayetteville, Ark.

H. J. Ashe, recent graduate of the Colorado School of Mines, has a job with the Inspiration Copper Co. His address is Box 96, Inspiration, Ariz.

L. J. Barraclough, chief mining engineer to the 3,000 - ton - per - day Indian coal company, Messrs. Andrew, Yule & Co., visited the States on business and as the delegate of the Mining, Geological and Metallurgical Institute of India to the UN Conference on the Conservation and Utilization of Natural Resources in August. An authority on hydraulic stowage in Indian mines, he holds several government appointments.

Mr. Barraclough left New York on his way home early in September after visiting coal mining properties in Pennsylvania. He suggests that any AIME members wishing to visit India should get in touch with P. K. Ghosh, Honorary Secretary of the Mining and Geological Institute of India, care Geological Survey of India, Calcutta, who will arrange for a proper reception.

H. L. Batten, who for some years has been consulting engineer for Canadian Exploration, Ltd., and manager of the Emerald Tungsten Project, Salmo, B. C., has established an office at 704 Birks Bldg., Vancouver, B. C., and will carry on a general consulting practice specializing in development projects in British Columbia.

Jacob P. Berry for the past two years had been general superintendent of Moccasin Mines, Ltd., at Watson Lake, Yukon Territory. Recently he resigned this post to become manager of the United Mining and Dredging Co. operating in the Cariboo area of British Columbia.

J. J. Kelleher

J. J. Kelleher has been made assistant sales manager, a newly created post, for the Hercules Powder Company's explosives department. For several years he was manager of the Company's contractors division. He has worked on some of the major construction jobs in the country.

Dwight L. Harris

Dwight L. Harris resigned as assistant professor of metallurgy in the School of Mines at Washington State to continue graduate work at MIT. A research assistantship at the Institute in radioactive tracer investigations has been granted him. He expects to complete work for a doctorate at the same time.

J. T. Boyd has an avocado grove near Carlsbad, Calif., and although somewhat slowed down by Parkinson's disease, has been making mine examinations in California, Nevada, and Mexico.

Walter W. Bradley married the former Mrs. John R. Roberts last April. While on a trip to the East Coast in August they stopped in at AIME headquarters.

Lloyd D. Brownson is assistant to the engineers of the U. S. Smelting Refining and Mining Co., at Lark, Utah.

E. L. Bruce, Miller Memorial professor and head of the department of geology at Queen's University, Kingston, Ont., has been elected vice-president of the Society of Economic Geologists for 1950.

R. D. Bradford, of San Francisco, has been named general manager of the Utah department of the American Smelting and Refining Co., succeeding **W. J. O'Connor,** who retired on May 1. Mr. O'Connor had served AS&R for 39 years, and spent 32 of them in Utah. Mr. Bradford joined the Company in 1926, and has worked in its New York, East Helena, Mont., and El Paso, Texas, operations.

J. Ross Clare, formerly with the Lamaque Mining Co., can now be reached in care of the Canadian Johns Manville Co., Matheson, Ont.

Frank A. Colbert is in Rancagua, Chile, working as junior mine shift boss for the Braden Copper Co.

W. A. Coster, formerly with the Demerara Bauxite Co., is carrying out an assignment for the Afghanistan Government.

Robert I. Davis is working for Cia. Minera Sta. Maria del Oro, Sta. Maria del Oro, Durango, Mexico.

Danford J. Dodds is employed by the Bagdad Copper Corp., Bagdad, Ariz., as assayer-chemist. Prospecting is good in that area and excitement growing over the recent discovery of U_3O_8 at the nearby Hillside mine.

Muri H. Gidel, chief geologist of the Anaconda Copper Mining Co., has been elected president of the Alumni Association of the Montana School of Mines for the ensuing year.

T. R. Goedicke has left Sherwin Kelly Geophysical Services to return to the University of North Carolina,

Chapel Hill, where he is studying for his doctor's degree in geology.

Patrick Green, formerly general mine foreman for Patiño Mines and Enterprises, may be reached temporarily at home, where his address is Box 622, Cashmere, Wash.

Thomas A. Greene is now an assistant engineer with the Anaconda Copper Mining Co., and can be reached at 2601 Princeton Ave., Butte, Mont.

Wm. A. Griffith, having completed requirements for a master's degree at MIT, where he was an instructor, has taken a job with the New Jersey Zinc Co. at Palmerton, Pa.

Donald R. Haake, formerly in the production department of the Rochester & Pittsburgh Coal Co., has gone to Wheeling, W. Va., as industrial engineer for the Valley Camp Coal Co.

George R. Haataja can now be reached in care of the Braden Copper Co., Rancagua, Chile.

Coming Meetings

OCTOBER

- 3 **Boston Section, AIME.**
- 3-4 National Assn. of Corrosion Engineers, Adolphus Hotel, Dallas, Texas.
- 3-6 Assn. of Iron and Steel Engineers, William Penn Hotel, Pittsburgh.
- 5 **Chicago Section, AIME. R. S. Archer on "Temper Brittleness in Steels."**
- 5-7 **Petroleum Branch, AIME, fall meeting, Plaza Hotel, San Antonio, Texas.**
- 6 American Iron and Steel Institute, Drake Hotel, Chicago.
- 7 **Columbia Section, AIME.**
- 10-14 American Society for Testing Materials, Fairmont Hotel, San Francisco.
- 11 **Delta Section, AIME. Discussions on company organization.**
- 11 **East Texas Section, AIME.**
- 11-14 American Standards Assn., annual meeting, New York City.
- 12 **El Paso Metals Section, AIME.**
- 12 **Southwestern New Mexico Section, AIME.**
- 12 **San Francisco Section, AIME.**
- 13 **New York Section, AIME. M. L. Haider on "Canadian Oil Developments."**
- 13 ASME, Metropolitan Section Night.
- 13-14 Texas Mid-Continent Oil and Gas Association, annual meeting, Rice Hotel, Houston.
- 14 **Eastern Section, Open Hearth Committee, Iron and Steel Division, annual all-day fall meeting, Warwick Hotel, Philadelphia.**
- 14 **Southwestern Section, Open Hearth Committee, Iron and Steel Division, Kansas City, Mo.**
- 14 **Rio de Janeiro Section, AIME.**
- 17 **Detroit Section, AIME.**
- 17-19 **Institute of Metals Division, AIME, fall meeting, Allerton Hotel, Cleveland.**
- 17-21 National Metal Congress and National Metal Exposition, Public Auditorium, Cleveland, Ohio.
- 17-21 American Society for Metals, annual meeting, Cleveland, Ohio.
- 17-21 American Welding Society, annual meeting, Cleveland, Ohio.
- 17-23 AIEE, 1949 Mid-West meeting, Netherland Plaza, Cincinnati.
- 18 **Gulf Coast Section, AIME.**
- 18 **Washington, D. C., Section, AIME.**
- 19 **Southwest Texas Section, AIME.**
- 19-20 Society for Non-Destructive Testing, Cleveland, Ohio.
- 20 **Carlsbad Potash Section, AIME.**
- 20 **Utah Section, AIME.**
- 20-21 **S. Calif. Section fall meeting, with Petroleum, Mining and Metals Branches, Los Angeles.**
- 21 **Oregon Section, AIME.**
- 24-28 Thirty-seventh National Safety Congress and Exposition, Chicago.
- 25 **Montana Section, AIME.**
- 26-27 **Joint Fuels Conference, ASME-AIME, French Lick Springs Hotel, French Lick, Ind.**
- 28 **Pittsburgh Section of Open Hearth Committee and Pittsburgh Section, AIME, annual fall meeting, William Penn Hotel, Pittsburgh.**
- 28 **Delta Section, AIME, Hallowe'en dance and buffet dinner, Metairie County Club, New Orleans.**
- 28-29 ECPD, annual meeting, Edgewater Beach Hotel, Chicago.
- 31 **Alaska Section, AIME.**

NOVEMBER

- 1 Society for Applied Spectroscopy, New York City.
- 1-5 Pacific Chemical Exposition, California Section, American Chemical Society, San Francisco Civic Auditorium.
- 2 **Chicago Section, AIME. Ladies Night. J. P. Skinner on "Synthetic Sapphire."**
- 2-4 American Society of Civil Engineers, fall meeting, Washington, D. C.
- 4 **Columbia Section, AIME.**
- 7 **Boston Section, AIME.**
- 7-10 AIChE, annual meeting, Pittsburgh, Pa.
- 7-12 International congress on tunnel driving in rock formation, organized by the Societe de l'Industrie Minerale. Information on meeting available from French Mining Mission, 1322 18th St., N. W., Washington, D. C.
- 8 **Delta Section, AIME. Problems of offshore drilling.**
- 8 **East Texas Section, AIME.**
- 8-11 **Industrial Minerals Division, AIME, Tampa, Fla.**
- 9 **El Paso Metals Section, AIME.**
- 9 **San Francisco Section, AIME.**
- 9 **New York Section, AIME. Ladies Night. C. Goodman on "Atomic Energy."**
- 10-11 National Air Pollution Symposium, Huntington Hotel, Pasadena, Calif.
- 10-14 ASTM, first Pacific area national meeting, San Francisco, Calif.
- 11-12 **Central Appalachian Section, AIME., and W. Va. Coal Mining Inst., Summit Hotel, Uniontown, Pa.**
- 11 **Rio de Janeiro Section, AIME.**
- 12-14 Geological Society of America, annual meeting, Hotel Cortez, El Paso.
- 14 **Arizona Section, AIME, annual meeting, Pioneer Hotel, Tucson.**
- 15 **Gulf Coast Section, AIME.**
- 15 **Washington, D. C., Section, AIME.**
- 16 **Southwest Texas Section, AIME.**
- 16-18 Industrial Hygiene Foundation, 14th annual meeting, Mellon Institute, Pittsburgh.
- 16-18 **Geological Society of America, annual meeting, Hotel Statler, Washington, D. C.**
- 17 **Carlsbad Potash Section, AIME.**
- 17 **Utah Section, AIME.**
- 28-Dec. 3 22nd Exposition of Chemical Industries, New York City.

DECEMBER

- 4-7 AIChE, national meeting, Pittsburgh, Pa.
- 7 American Mining Congress, Annual Business Meeting, New York City.
- 7-9 Eighth Annual Conference, Electric Furnace Steel Committee, Iron and Steel Division, AIME, Hotel William Penn, Pittsburgh.
- 8-10 **Seventh Annual Conference, Electric Furnace Steel Committee, Iron and Steel Division, AIME, Hotel William Penn, Pittsburgh.**

JANUARY 1950

- 18-20 American Society of Civil Engineers, annual meeting, New York.
- 30 AIEE, winter meeting, New York.

FEBRUARY 1950

- 10 **Southwestern Section, Open Hearth Steel Committee, Iron and Steel Division, St. Louis, Mo.**
- 12-16 **Annual Meeting, AIME, Statler Hotel, New York City.**

APRIL 1950

- 4-7 Nat'l Assn. of Corrosion Engineers, St. Louis.
- 10-12 **Open Hearth Conference, and Blast Furnace, Coke Oven and Raw Materials Conference, Netherlands Plaza Hotel, Cincinnati.**
- 19-21 American Society of Civil Engineers, spring meeting, Los Angeles.
- 23-26 American Ceramic Society, annual meeting, New York City.
- 24-26* AMC Coal Convention, Netherlands Plaza Hotel, Cincinnati, Ohio.

DECEMBER 1950

- 7-9 **Electric Furnace Steel Conference, Iron and Steel Div., Hotel William Penn, Pittsburgh.**

APRIL 1951

- 2-4 **Open Hearth and Blast Furnace, Coke Oven and Raw Materials, Conference, Iron and Steel Division, Statler Hotel, Cleveland, O.**

Daniel A. Jones is employed by the Territory of Alaska as assayer and mining engineer at the Nome assay office. Most of the summer was spent in examinations and examining samples to assay during the winter. It is his job to help further in every way possible the mining industry in northwestern Alaska.

Peter Joralemon completed his studies at Harvard, receiving a doctor's degree in geology, and is now working as a geologist for Getchell Mine, Red House, Nev.

Lou D. Jordan, formerly general superintendent of the Consolidated Mines for the Benguet Consolidated Mining Co. in the Philippines, has returned to the Western Hemisphere to work for the San Francisco Mines of Mexico at San Francisco del Oro, Chihuahua.

Thomas F. Kearns was reelected last May as president of the Silver King Coalition Mines. At the same time, **James Ivers** became vice-president and general manager, and **M. G. Heitzman** took over as manager of operations.

L. Russell Kelce of Kansas City has been elected to serve as a director of the National Coal Association. Mr. Kelce recently became president of the Sinclair Coal Co., and has been with that Company since 1924.

John M. Kerr is now serving as general manager of the Berwind-White Coal Mining Co. in Windber, Pa., thus moving up from his former post as general superintendent.

Daniel N. Klemme can be reached at the Hancock Oil Co. of California, 2828 Junipero, Long Beach, Calif.

R. P. Kinkel has resigned as manager of Buffalo Ankerite Gold Mines, Ltd., S. Porcupine, Ont.

Mack C. Lake has been appointed consulting engineer exclusively for the Oliver Iron Mining Co. and other U. S. Steel Corp. subsidiaries. He will deal largely with the company's ore developments in foreign fields.

Stanley Lefond is working for the Mene Grande Oil Co., Apartado 234, Maracaibo, Venezuela.

W. D. Lowry, until recently a geologist with The Texas Co. in California, has joined the staff of Virginia Polytechnic Institute, Blacksburg, Va., as associate professor of geology.

Robert C. McCain is working for the Frontier Refining Co. as an assistant geologist. Mail reaches him at Box 574, Durango, Colo.

I. H. McLean has taken up an appointment as a mining engineer in India and is addressed care of Agent, Central Provinces Manganese Ore Co., Nagpur, C.P., India.

Morris M. Menzies received his degree in geological engineering from the University of British Columbia, Vancouver, last spring, worked as a junior geologist for the Hudson Bay Mining and Smelting Co., and returned to Vancouver for postgraduate work this fall.

Paul Klempner

Paul Klempner and his wife recently arrived from Johannesburg, South Africa, for an extended tour of the United States. Mr. Klempner is a consulting engineer and just prior to his departure from South Africa he designed and supervised the erection of an asbestos plant and completed a number of surveys including reports on manganese, chromium, tungsten, and gold deposits.

Charles S. Merriam has been appointed head of the Solid Fuels Branch of the Mining and Geology Division, Natural Resources Section, SCAP, replacing **Daniel J. Carroll,** who has been transferred to the Economic and Scientific Section of SCAP as supervisor of coal production. The two men will co-ordinate the efforts of the two sections to keep coal production up, as well as to improve coal cleaning and preparation, use of mechanical equipment so far as is possible and to better utilization in Japan.

Pomeroy C. Merrill has left his post with the Eastern Mining and Metals Co. in Malaya. An attack of pneumonia forced him to take the first boat back to the States. **Robert E. Tally, Jr.,** has taken over his job.

Hugh D. Miser, of the U. S. Geological Survey, nationally known expert on petroleum geology, received the degree of Doctor of Laws at the 75th commencement of the University of Arkansas. The citation read: "your devotion to science and your high standards of scholarship and research have been a constant source of inspiration. You have explored many unknown paths of knowledge."

James W. Morgan became vice-president and general manager of the Ayrshire Collieries Corp. on Sept. 1. Connected with the coal industry since he graduated from Lehigh in 1921, he worked for C. A. Hughes & Co. until accepting the post of assistant to the vice-president in charge of operations of Truax-Traer's Eastern mines in 1948.

Alexander R. Mutch, formerly a student at Otago School of Mines, has the job of assistant geologist on a coal survey with the New Zealand Geological Survey, Balclutha, N. Z.

E. N. Pennebaker expects to be in South Africa until the end of the year reviewing geological and exploration problems for the O'okiep Copper Co.

J. S. Peterson and his wife are on a round-the-world pleasure trip and will spend the remainder of the year in the States on business and vacation. Mr. Peterson is vice-president and assistant general manager of the Benguet Consolidated Mining Co., Baguio, P. I.

R. E. O'Brien, who had been with the Mountain City Copper Co., is working for the Anaconda Copper Mining Co. at Conda, Idaho.

H. Gordon Poole, who had a year's leave of absence, from his post as professor of mining engineering at the University of Washington, is returning from Mexico City where he was attached to the American Embassy as a mining and metallurgical consultant of the Bureau of Mines to the Mexican Government.

H. N. Propp has been made assistant district manager, central territory, crusher and process machinery division, Nordberg Mfg. Co. He has transferred to Milwaukee, Wis., from the San Francisco district office where he served as sales engineer for the past year.

Norman Phillips recently joined the chemical laboratory staff of the research and development department of the Babcock & Wilcox Co. in Alliance, Ohio.

James Quigley has completed a month's study of the Marysvale, Utah, uranium district for the Centennial Development Co. **Harold B. Spencer** is president of Centennial and is in charge of the Company's shaft sinking and tunnel driving activities.

P. H. Reagan, consulting mining engineer of Hye, Texas, returned from Nicaragua and has gone to Western Australia. He expects to return to his office in December.

Robert St. Clair is employed by the Carnegie-Illinois Steel Co. at their

Ohio district works as a process engineer.

Raymond E. Salvati, operating vice-president of the Island Creek Coal Co., was elected president of the Boston, Mass., Company at the June meeting of the board.

H. Sano, who retired as professor of the College of Engineering at Tokyo Imperial University to act as director of the Coal Board, is now Emeritus Professor at the University. As director of the Coal Board he endeavored to increase coal production in Japan in co-operation with officials of the Allied Powers, among whom he found many AIME members.

Hans H. Schou can be reached at the Frontino Gold Mines, Ltd., Segovia, Antioquia, Colombia.

George P. Schubert, since the closing of the Copper Range Smelter, has taken over as professor in charge of shops and drawing at Michigan College of Mining and Technology.

Munshi Lal Sethi has been minerals adviser to the Government of Jaipur since February. Eighteen different Indian States have formed the new province of United States of Rajasthan, covering an area of about 125,000 sq mi. In June Mr. Sethi received appointment as director of mines and geology to this new province in addition to his duties as minerals adviser.

Joseph G. Sevick graduated from the Missouri School of Mines in May and has become associated with the research department of the zinc division of the St. Joseph Lead Co., Monaca 7, Pa. He lives at 1200 Penn Ave., New Brighton, Pa.

A. Ben Shallit has been appointed superintendent of Carbonate Mines, Inc., Bald Butte, Mont.

James C. Shields, II, since last November has been doing geological field work in Cuba, practically all in Oriente Province. He is resident geologist for Geological Engineering Consultants (Cuba), Inc., in Havana.

Carl W. Sinclair retired from the staff of John A. Roebling's Sons Co. on July 1. He can be reached now at the Galigher Co., 545 W. 8th S., Salt Lake City 8.

L. E. Sinclair has resigned from Mount Isa Mines, Ltd., to go to New Caledonia, where he will be in charge of Establissement Baelande's mining interests in that island.

James T. Smith, who had been studying at the University of British Columbia, can be reached in care of Roan Antelope Copper Mines, 64 East Rand, Luanshya, N. Rhodesia.

Francis B. Speaker has transferred to the New York City office of Hewitt-Robins, Inc. As field engineer he will work out of the New York office for both Robins conveyors division and Hewitt rubber division.

Carsten Steffens has resigned as assistant director of Stanford Research Institute to take the post of associate professor of chemistry at the University of New Mexico in Albuquerque.

A. George Stern, former chief of the western research division of the Westvaco Chlorine Products Corp., is Pacific Coast manager of the Heyden Chemical Corp., San Francisco. His home address is 764 Forest Ave., Palo Alto, Calif.

Edward M. Thomas

Edward M. Thomas heads the Bureau of Mines newly established roof-control section of the health and safety division; the section will further the attack on the No. 1 killer in the nation's coal mines, falling rock and coal. While a major project of the new section is the adaptation of suspension roof support to more general use in mining, it will attack all phases of the roof-control problem through education, investigation, and research.

John K. Stewart is an engineer in training with Hollinger Consolidated Gold Mines Ltd., Timmins, Ont. His address in Timmins is 11 James Ave.

H. W. Straley, III, consulting geological and geophysical engineer, after spending a year in eastern Oklahoma has moved his office from Friendship Station, D. C., to Box 68, Princeton, W. Va. Temporarily he may be reached at 1459 Cameron Terrace, Drury Hills, Atlanta, Ga.

H. S. Taylor, who has been general counsel and vice-president in charge of mining operations, is the new president of the 95-year old iron ore, coal, and lake shipping concern, Oglebay, Norton and Co. Mr. Taylor was engaged in law practice for several years before joining the Company and is active now in many associations.

Alberto J. Terrones L., after spending a 4½ month leave in Mexico visiting operations there, returned to the Cerro de Pasco Copper Co. and his new job of geologist of the Cerro de Pasco division.

Gustave W. Voelzel and his wife made a six week trip this summer through Canada and New England. They visited AIME headquarters in New York City and returned to El Paso, Texas, by way of Niagara Falls.

J. K. Whatmough was appointed mine manager of Starratt Olsen Gold Mines, Ltd., Madsen, Ont., on June 1.

J. A. Willcox has a job with the Polaris-Taku Mining Co. in Tulsequah, B. C.

Alexander N. Winchell, after an interesting year as visiting professor of geology at the University of Virginia, has returned to his home at 88 Vineyard Rd., New Haven, Conn., where he will resume his editorial and consulting work in the field of mineralogy and crystallography.

P. F. Yopes is employed as a mining engineer with the safety division of the Bureau of Mines, working out of the Seattle office.

—In the Metals Branch—

Edgar C. Bain, vice-president in charge of research and technology at the Carnegie-Illinois Steel Co., will have two medal-receiving days in October. On the 19th he will get the John Price, Wetherill Medal of the Franklin Institute of the State of Pennsylvania, awarded for discovery or invention in the physical sciences or for new and important combinations of principles or methods already known. On Oct. 20 he will receive the Gold Medal of the ASM (see September Personals).

C. G. Benson, who has been with General Electric since graduation from Harvard, helped set up the Company's new plant in Brockport, N. Y. The major portion of his work has been in manufacturing methods and plant layout, with some specializing in plastic molding.

John O. Cartledge recently was promoted from the post of shift superintendent to assistant works metallurgist at the Port Pirie works of the Broken Hill Associated Smelters Pty. Ltd.

R. H. Covington has changed his address from the American Zinc Co. of Illinois, Dumas, Texas, to the

American Zinc Oxide Co., P. O. Box 327, Columbus 16, Ohio.

H. R. Dahlberg has left his post as assistant professor of industrial engineering at Oregon State and has joined the Twin City Testing and Engineering Laboratory as supervisor in the mechanical and metallurgical department in St. Paul, Minn.

Reginald S. Dean, metallurgical engineer and consultant of Washington, D. C., has moved his offices to 6000 34th Place, N.W., Washington 15. Dr. Dean is also president of R. S. Dean Laboratories, which has just moved into its own laboratory and office building at 5810 47th Ave., Riverdale, Md., just outside Washington.

Robert A. Eastman has the job of chemist at the Great Falls reduction works of the Anaconda Copper Mining Co. He can be reached at 821 3rd Ave. S.W., Great Falls, Mont.

John E. Gaus has left the ranks of metallurgists to enter the broader field of the entire mineral industries as curator of the Mineral Industries Museum at Penn State.

Robert E. Hagen is working in the research laboratory of the Oliver Iron Mining Co. in Duluth, Minn.

E. Hartshorne has transferred to New Haven, Conn., where he is assistant director of research and development for Winchester Repeating Arms Co., division of Olin Industries.

Robert H. Jacoby is chief metallurgist of the Key Co., 2700 McCasland Ave., East St. Louis, Ill.

T. G. Johnston, Jr., after receiving his degree in metallurgical engineering from Purdue in June, accepted the job of junior metallurgist in the metallurgical department of the National Tube Co. in Lorain, Ohio.

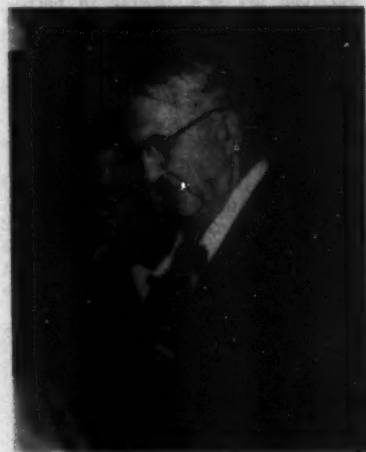
Jerome W. Kaufman, a recent Lehigh graduate, has a job as metallurgist at the Naval Air Material Station, Johnsville, Pa.

William C. Leslie, who has been a student at Ohio State, is working in the research laboratory of the U. S. Steel Corp. at Kearny, N. J.

Francis F. Lucas has retired from the Bell Telephone Laboratories. He can be reached at his home, 245 Rutledge Ave., East Orange, N. J.

N. E. Nilsen has been promoted to chief general manager of the Emperor, Loloma and Dolphin Mining Companies, with headquarters in Melbourne, Australia. Former general manager of the companies' properties at Vatukoula, Fiji, he will spend about half his time there.

Elliott S. Nachtman has been named instructor in metallurgical engineering at the Illinois Institute of Technology. He had served as a chemist for the Harshaw Chemical Co. and held a similar job with the Argonne National Laboratory.



Donald M. Liddell catches up with the news; the man behind him is unknown.

Donald M. Liddell returned to New York City in August after a 2½ months' professional trip to England and the Continent, which included participation in the Empire Mining and Metallurgical Congress.

Eric G. Peterson

Eric G. Peterson has been appointed general manager of the Peabody Engineering Corp., New York City, and will continue as general sales manager of all the Company's products in all divisions. Already known as one of industry's leading designers of combustion equipment, Mr. Peterson's new duties will broaden his supervision and interest to include the activities and welfare of all the Peabody offices and subsidiaries throughout the world.

Fred D. Rosi, formerly at the Hammond Metallurgical Lab., Yale, is now reached at the Research Laboratories, Sylvania Center, Bayside, L. I., N. Y.

John W. Pugh is with the General Electric Co., Rm. 522, Bldg. 5, Schenectady, N. Y.

Waldemar P. Ruemmler has succeeded **G. E. Johnson** as manager of the East Chicago plant of the Eagle-Picher Co. He joined Eagle-Picher in 1948 and has been successively in charge of research and development, and acting superintendent at East Chicago. Prior to this affiliation he was associated with Battelle Memorial Institute.

Edgar Sengier, managing director and chairman of the executive committee of Union Miniere du Haut-Katanga, has been honored by the French Government with the order of Commander of the Legion of Honor. This high decoration, together with the U. S. Medal for Merit and the Commander of the British Empire previously conferred, are in recognition of the outstanding services rendered by Mr. Sengier during the war years to Belgium's three great allies.

Morris A. Steinberg has been made a member of the board of directors of Horizons, Inc., of Princeton, N. J., and Cleveland, Ohio. The war had interrupted his studies, but after receiving his doctorate in physical metallurgy in July of 1948 he joined Horizons, Inc., and in March 1949, was appointed head of the metallurgy division.

John E. Stukel, Jr., has joined the operating department of the Youngstown Sheet and Tube Co. as a development engineer. He was assistant professor at Carnegie Institute of Technology.

John M. Thomas, research associate at the University of Michigan, has a new address at 3147 Vassar St., Dearborn, Mich. He is metallurgical engineer with the Hoskins Mfg. Co., of Detroit.

George H. Thurston, formerly with American Smelting and Refining at Selby, Calif., is now metallurgist with the Hall-Scott motor division, ACF-Brill in Berkeley.

William V. Ward, who has been with the Division of Industrial Cooperation at MIT doing research work sponsored by the Atomic Energy Commission during the summer, plans this fall to enroll in the graduate school at MIT to start work towards the degree of science doctor in metallurgy. His wife and son accompanied him to Massachusetts from the University of Arizona with which he was connected in a student-instructor capacity. Their new address is 349 Westgate West, Cambridge, Mass.

W. E. Mahin

W. E. Mahin, chairman of metals research at Armour Research Foundation of the Illinois Institute of Technology, has been named director of research. He heads a group of 411 scientists, engineers, and technicians who are working on 125 active research projects for industrial and government sponsors. For ten years previous to his joining the Research Foundation in 1947, Mr. Mahin was in charge of metallurgical engineering at the Westinghouse Electric Corp., Pittsburgh.

Ervin E. Underwood, after obtaining his B.S. degree in metallurgical engineering at Purdue, has moved to MIT for graduate work in their school of metallurgy.

B. H. Wadia has gone to Oroya, Peru, to work for the Cerro de Pasco Copper Co.

—In Petroleum Circles—

Roy F. Beery, Jr., formerly with the Shell Oil Co., has become division superintendent for the Danciger Oil and Refining Co., Norman, Okla.

George W. Burgess, junior exploitation engineer with the Shell Oil Co., can be reached in care of the Company, Box 488, Denver City, Texas.

Robert A. Coleman is a petroleum engineer trainee with the Gulf Oil Corp., with a mailing address at General Delivery, Kermit, Texas.

James Terry Duce is now residing in New York City, having moved from Washington, D. C., when executive offices of the Arabian American Oil Co., of which he is a vice-president, were established in the former city.

Thomas M. Esmond, who graduated from Texas Tech with a B.S. degree in petroleum geology last May, is employed by R. C. Lipscomb Oil Producer in San Antonio, Texas, as a geologist.

Martin Felsenthal joined the Continental Oil Co at Ponca City, Okla., on Aug. 1, to work as research engineer in the production laboratory of the Company's research and development department. Recently he received his M.S. degree in petroleum engineering from Penn State.

Lester S. Grant went into full retirement as vice-president of the Franco Wyoming Oil Co. and vice-president and manager of McElroy Ranch Co. on June 1. In July he and Mrs. Grant made a three week pleasure trip to Alaska and expect to attend the 75th anniversary of the Colorado School of Mines. He can be reached care of McElroy Ranch Co., Box 912, Midland, Texas.

Diego Henao-Lindoño is with the Servicio Geológico Nacional de Colombia, Bogota, as a geologist.

Herbert A. Koch

Herbert A. Koch, general sales engineer for Dowell Incorporated in Tulsa, has been appointed head of the Fort Worth, Texas, office. Sales co-ordinator in the Fort Worth-Dallas area, he will have special responsibilities throughout Texas, Louisiana, and New Mexico. An alumnus of the University of Oklahoma, Mr. Koch has been with Dowell since 1944 and has received special training with the Company in electric pilot services.

Bart W. Gillespie is general manager for the Mexican American Independent Co., Reforma No. 1, Despacho 204, Mexico, D.F., Mexico.

William R. Goodier, formerly associated with the Shell Oil Co. in Great Bend, Kans., is now employed by the Barnsdall Oil Co., Newhall, Calif., as a petroleum engineer.

J. T. Holten, Jr., recent graduate of the University of Oklahoma, is working as an engineer for the Mid-Continent Petroleum Corp., Seminole, Okla.

M. King Hubbert, associate director of research of the Shell Oil Co. exploration and production research laboratory, served as a U. S. delegate to the United Nations Scientific Conference on Conservation and Utilization of Resources held at Lake Success, N. Y., Aug. 17 to Sept. 6.

Robert K. James is working at Eunice, N. Mex., as a petroleum engineer trainee with the Magnolia Petroleum Co.

Howard F. Johnston, district geologist for the Quaker State Oil Refining Corp., has been transferred from Newark, Ohio, to the newly opened production offices at Parkersburg, W. Va.

Paul S. Johnston has taken the post of professor of petroleum engineering at Texas Technological College, Lubbock, Texas.

Norris Johnston has been named president of the consulting firm Petroleum Technologists, Inc., in Montebello, Calif. For the past ten years he had been chief physicist in charge of production research for the General Petroleum Corp. During this period he was assigned to Socony-Vacuum to set up their Dallas production research laboratories.

Gordon H. White recently resigned from the Shell Oil Co. to join the ranks of the independent operators. He has incorporated his own company under the name of the Niles Oil Co., with headquarters at 1406 M & W Tower Bldg., Dallas, Texas. His work with Shell had taken him to many of the oil producing areas

Gordon H. White

of this country; in 1938 he was sent to the Hague, Holland, returning to the Houston office in mid-1939.

Eugene L. Davis, formerly general production superintendent for the Signal Oil and Gas Co., Los Angeles, has accepted the post of project manager of the Arctic Contractors,

Eugene L. Davis

Fairbanks, Alaska. The Arctic Contractors, under contract to the Navy, are conducting oil exploration activities in Naval Petroleum Reserve No. 4, Point Barrow, Alaska.

M. C. Leverett joined the NEPA (nuclear energy for the propulsion of aircraft) project at Oak Ridge, Tenn., as its technical director in June. The NEPA project is a division of the Fairchild Engine and Aircraft Corp. and its work is under the U. S. Air Forces. Mr. Leverett was formerly research associate with the Humble Oil and Refining Co.

Arthur Maddox has been transferred from the International Petroleum Co., Barcelona, Venezuela, to the Carter Oil Co. in Tulsa, Okla.

Melford F. Rabalais has changed his mailing address to Kerr-McGee Oil Industries, Inc., Sunray, Texas.

Glenn Nelle has joined the General Petroleum Corp. as assistant manager of Rocky Mountain operations. Mr. Nelle had been in Venezuela with Socony-Vacuum.

E. E. Rehn has announced his resignation as division geologist of the Western Division of the Sohio Petroleum Co., and is returning to Evansville, Ind., to open consulting geological offices at 308 Grein Bldg.

Bruce H. Sage, professor of chemical engineering at California Institute of Technology, was given the new $1,000 Precision Scientific Co. award in petroleum chemistry at the recent national meeting of the American Chemical Society. He is credited with having significantly enlarged the recoverable natural oil resources of the country during his nineteen years of research.

N. van Wingen, professor of petroleum engineering of the University of Oklahoma, has resigned to join, as vice-president, the consulting firm, Petroleum Technologists, Inc., in Montebello, Calif. Prior to joining the University staff, he had been associated for nine years with the Richfield Oil Corp.

Herbert N. Wade is with The Texas Co. in Buckeye, N. Mex., as an engineer trainee.

Theodore G. Ward, Jr., has taken the job of junior engineer with the Atlantic Refining Co., Dallas, Texas.

David B. Wilke, Jr., after graduation from the University of Kansas with a B.S. degree in petroleum engineering, was employed by the Skelly Oil Co. He is working in their New Mexico district and can be reached at Drawer D, Hobbs, N. Mex.

Walter L. Williams is an engineer trainee with American Republics Corp., Silsbee, Texas. His address there is P. O. Box 451.

Obituaries

Charles Worth Fowler, Jr. (Member 1942), president of United Oilwell Service, Caracas, Venezuela, died Sept. 30, 1948. He was 49 years old. Most of Mr. Fowler's career was spent in Mexico and South America; he had been with the Mexican Gulf Oil Co., Yacimientos Petroliferos Fiscales, Argentina, and the Pantepec Oil Co. of Venezuela. He was also a junior member of Brokaw, Dix, Garner & McKee.

Charles W. Fowler, Jr.

Paul Armitage (Member 1918), noted corporation lawyer and an expert in taxation practice, died on June 28. Mr. Armitage was a member of the law firm of Armitage and Holloway in New York City, which firm had been counsel to the Woolworth Estates, the United Verde Extension Mining Co., the G. R. Kinney Co., to name but a few. Mr. Armitage graduated from Columbia University in 1894 and from Columbia's Law School two years later. He was admitted to the bar in the same year, and, in 1905, admitted to practice before the U. S. Supreme Court.

Mr. Armitage, a champion figure skater in his youth, was a founder of the New York Skating Club. He was also a member of the Academy of Political Science, the American Bar Association, and a director of a number of firms.

Percy A. E. Armstrong (Member 1924), a leader in the development of stainless steel, died on Aug. 7 after a long illness. Born and educated in England, he came to this country 30 years ago. Nationally recognized for his work in metallurgy, he was an early developer of stainless steel and held more than 100 patents on steel alloys. Mr. Armstrong was a vice-president and general manager of the Allegheny Ludlum Steel Co.

William Albert Baueris (Member 1936), mining engineer of Seattle, Wash., died on Feb. 23 at the age of 65. Mr. Baueris had a long and varied career in exploration, mining, construction, and manufacturing. It began in 1900 when he worked for five years as a structural draftsman and field superintendent for the Chicago Bridge and Iron Works. In 1909, he graduated from the Missouri School of Mines, did some geological reconnaissance, worked in the Homestake mine for a year, and then spent twelve years with the Puget Sound Bridge & Dredging Co. in Seattle. From 1922 to 1925 his were various activities associated with gold mining, and 1936 found him examining Bonanza Creek and Ungalik River deposits in the Norton Sound area of Alaska. Later, he headed the Ungalik Syndicate, finally retiring in 1942.

William Bell (Member 1936), of Robinson, Ill., is dead. Mr. Bell, who was born in Franklin, Pa., on Aug. 29, 1874, had been an independent owner and operator of oil producing properties in Pennsylvania, West Virginia, Indiana, and Illinois, for the past 50 years.

Necrology

Date Elected	Name	Date of Death
1897	Thomas J. Barbour	Unknown
1914	Z. T. Crittenden	March 25, 1949
1946	Henry Davenport	Unknown
1933	Carl Erickson	June 28, 1949
1919	Charles T. Evans	May 13, 1949
1938	Dwight H. Fortine	Aug. 3, 1949
1944	Russell J. Parker	Sept. 9, 1949
1928	R. C. Patterson	April 3, 1949
1920	E. T. Stannard	Sept. 9, 1949
1926	Arthur D. Storke	Sept. 9, 1949
1939	W. W. Taylor	Unknown
1920	C. Erb Wuensch	Aug. 27, 1949

Walter Frederic Bart Berger (Member 1907), died on June 6. Born in Denver in 1877, he attended the Colorado School of Mines for a year after graduating from Yale. He spent some time in Japan for the Chipman Chemical Co. and upon his return opened an office in New York City. He later moved to Denver to form the partnership of Berger & Sayre, mining engineers, and subsequently practiced independently. In recent years his home was in Victoria, B. C.

Walton Ambrose Bishop (Member 1945), died on June 10. He was 73 years old. Mr. Bishop had been with the Pocahontas Fuel Co., in Pocahontas, Va., for the past 43 years, and when he died, was the firm's chief engineer. Mr. Bishop was born in Snowville, Va., and was familiar with "Snowville wood, iron, steel, textile and grain mill machinery, from childhood." He was, for two years, operating engineer for the Radford Light and Power Co., then worked as an electrical engineer with the Virginia Iron Coal and Coke Co. before joining Pocahontas, in 1901.

Thomas Clark Botterill (Member 1942), died on June 15, at the age of 56. Mr. Botterill was a Canadian citizen although he was born at Rock Springs, Wyo. He pursued various studies in civil and mining engineering, and began his career as a draftsman in 1907. The next 25 years found him working as an engineer or superintendent on 12 different Canadian mining properties, including the Brittania Mining and Smelting Co., the Pacific Construction Co. In 1932 he formed his own consulting business, and from 1932 until his death his activities included both consulting and management work for numerous firms in British Columbia. His last position was managing director for the Hedley-Monarch Gold Mines in Vancouver.

John R. Comstock (Member 1920), general superintendent of the Pittsburgh Coke & Chemical Co. since Dec. 20, 1943, died suddenly July 14, 1949, at the Neville Island plant of the Company.

Mr. Comstock's outstanding personality and long association in the Merchant Blast Furnace field had given him a host of admiring friends and a national reputation in blast furnace operation.

A graduate of Stevens Institute of Technology in 1911 with a mechanical engineering degree, Mr. Comstock started his steel experience with the Pennsylvania Steel Co. at Steelton, where he became assistant superintendent of blast furnaces. In 1921 he was made assistant general manager of the Hanna Furnace Co. at Cleveland, and served in that capacity until 1931. In 1933 he was appointed general superintendent of the Globe Iron Co. at Jackson, Ohio, until 1943 when he became associated with the Pittsburgh Coke & Chemical Co. He was 58 years old at the time of his death.

George Bradstreet Dodge (Member 1939), vice-president of the American Rubber Mfg. Co., San Francisco, died in 1948. Born in Waukeegan, Ill., in 1880, he held various posts in the East and in 1906 became vice-president of the Western Belting Hose Co., the Lightning Hose Rack Co. and American Rubber, which later absorbed Western and Lightning.

Louis W. Huber

Louis W. Huber (Member 1937), vice-president of the National Mine Service Co., died Aug. 17, 1949. The suddenness of his death was a distinct shock to his many friends and associates in many mining fields of the country.

Born in Paris, Ill., May 13, 1899, his mining experience began early in life when he was but 15 years of age. He did everything there was to do in the underground operation of a coal mine from trapping and driving mule, on through coal loading, timbering, undercutting, electrical and mechanical repairs, maintenance, to face bossing in order to pay his own way through high school and college. All this practical underground work stood him in good stead later in life.

For two years after graduating from the University of Illinois in mining engineering in 1921, Mr. Huber was engaged in research work on mine ventilation and part-time teaching at his Alma Mater. Then he took the job of mine ventilation engineer in the Midwest for the B. F. Sturtevant Co. The fall of 1924, he joined the faculty of Carnegie Institute of Technology to teach mining engineering in the department of mining and metallurgy.

Four years later he became associated with Mine Safety Appliances Co. as sales representative in Cincinnati, Ohio, and steadily progressed in his work and responsibilities to become district manager. His service with this company extended over a period of 20 years, from 1928 to 1948.

On May 1, 1948, Mr. Huber was elected vice-president of National Mine Service Co. in charge of its two divisions in Kentucky, and all field operations and representatives in the states of Kentucky, Tennessee, Illinois, and Indiana. His home and headquarters for many years were in Lexington, Ky.

A foremost authority on mine ventilation, his services as a consultant were widely sought. In safety work, he served untiringly, and he was known throughout the country for his active participation and leadership in rescue work following many mine disasters.

Tore Flygare (Member 1947), Swedish mining engineer, died in November, 1947. Mr. Flygare, who had an E.M. degree from the Royal University of Technology in Stockholm, had been with Philippine Iron Mines for four years. In 1941 he joined the International Engineering Corp. in Manila, and at the time of his death was working with the Boliden Mining Co. in Boliden, Sweden.

Emil Gathmann (Member 1913), president of the Gathmann Engineering Co., the Gathmann Research Laboratories, Cantonsville, Baltimore, Md., former head of the Bethlehem Steel Company's ordnance department, inventor of note, died on Aug. 23. Holder of more than 100 patents for various types of metal he developed, he had invented a type of depth bomb to be used against submarines; many of his patents related to naval ordnance, particularly for fuses. A native of Chicago, where he was born in 1874, Mr. Gathmann went to Baltimore in 1909 after starting an engineering firm in New York.

Virgil O. Harris (Member 1943) is dead. Born at Bison, Okla., in 1907, he took his B. S. degree from Oklahoma University. Following graduation he joined the staff of the Humble Oil and Refining Co., with which he was associated at the time of his death.

Joseph Samuel Henry (Member 1918), mining engineer of Castlemaine, Vic., Australia, died on March 26. He was 73 years old at the time of his death. He received his technical education in Australia,

at the Technical College of Geelong in Victoria, worked for a time in London, and then was engaged in tin dredging operations in Siam and Australia. In recent years, before his retirement, he was a consulting engineer to the Austral Malay group and other companies "down under."

William D. Mark

An Appreciation By W. W. LYTZEN

William D. Mark (Member 1928), aged 44, mining engineer for the RFC, died suddenly of a heart attack on June 16 at his home in Chevy Chase, Md.

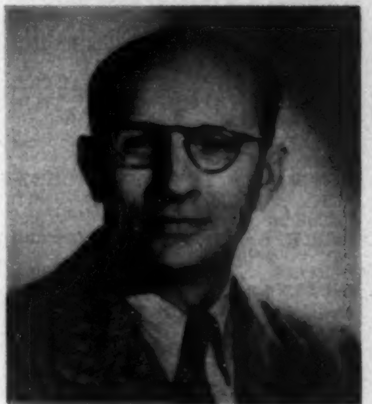
Bill joined the geological department of the Anaconda Copper Mining Co. at Butte, after graduating from the Idaho School of Mines, and in 1933 went to South America with the Cerro de Pasco Copper Co. as a geologist. Upon his return to this country he joined the RFC as field representative in Boise, Idaho, and Spokane, Washington, and for the past 13 years has been with the Washington Office of that Corporation.

Bill Mark was highly regarded, not only for his great personal integrity, but also for his integrity and ability in his profession. His sudden death came as a shock to his associates and many friends.

Walter Miller (Member 1918), of Ponca City, Okla., is dead. Mr. Miller was a vice-president of the Continental Oil Co. in that city. Born in Switzerland in 1881, Mr. Miller had little formal education and worked, until 1909, as a machine hand, blacksmith's helper, bookkeeper, and cost accountant, at which time he joined the Tidewater Oil Co. in Bayonne, N. J. He began there as a clerk, and within eight years had advanced to process superintendent. In 1919 he became a consulting refining engineer in Tulsa, and two years later joined the Marland Refining Co. in Ponca City, as manager of manufacturing. In 1930 he went with Continental Oil.

Clarence J. Peterson (Member 1916), died on May 8. Born in Honolulu, T. H., in 1885, Mr. Peterson received an A.B. degree in geology and mining from Leland Stanford Junior University in 1910, and spent the first six years of his career doing exploration work in Venezuela for the Bermudez Co. of Trinidad, and as an examining mining engineer for the Tonopah Mining Co. in Nevada. He then served as a geologist with such firms as the Empire Gas and Fuel Co. and the Cities Service Gas Co. until 1930, when he joined the Texoma Natural Gas Co. in Amarillo, Texas, as chief geologist. He held this position at the time of his death.

Victor H. Wilhelm (Member 1921), Captain USNR, died at the Long Beach Naval Hospital on July 7 after an illness of several months. He was 63 years of age, graduated as a geologist and mining engineer



Victor H. Wilhelm

from Stanford University in 1907, and followed mining and oil all of his life. After some years spent in all of the western states, Mexico, Canada, and Alaska, he settled down in California and was one of the early petroleum engineers of the State, being well known as an engineer and deputy supervisor with the California State, Division of Oil and Gas, then known as the State Mining Bureau. He became chief petroleum engineer of the Old Petroleum Midway and California Petroleum Companies and continued as such when those companies became The Texas Co. He will be remembered by a host of friends as the sage of the local petroleum industry and for his friendliness, advice, and counsel given particularly to young geologists and engineers.

In February of 1941 he was called to active duty as Lieutenant Commander in the Naval Reserve in the Office of Inspector Naval Petroleum Reserves in California and rose to the rank of Captain. He remained on active duty at the close of the war and has been the Inspector of Naval Petroleum Reserves in California since 1944.

E. A. Cappelen Smith (Member 1904), noted expert on metal refining, and consulting metallurgical engineer with Guggenheim Brothers in New York City, died on June 25 at the age of 75. Mr. Smith originated the Guggenheim method of extracting nitrate from caliche, and an extraction process used at the Chuquicamata plant of the Chile Exploration Co. His development of a method of basic copper converting was instrumental in revolutionizing the copper-smelting industry.

Born in Trondheim, Norway, he graduated from the Technical College of Trondheim and came to the United States in 1893. He became a chemist for the Chicago Copper Refining Co., later served as superintendent of Anaconda's electrolytic copper refinery, metallurgical engineer for the Baltimore Copper Smelting and Rolling Co., and a consultant with ASARCO in New York. He joined the Guggenheim brothers in 1912. From 1925 to 1931 he served as president of the Anglo Chilean Nitrate Corp., managing 62 per cent of all Chilean nitrate production.

Mr. Smith was a director of the Chile Copper Co., and the Chile Exploration Co. He held patents on processes used in the development of selenium, tellurium, platinum, and palladium from electrolytic copper refining slimes. His distinguished work in hydrometallurgy earned for him the gold medal of the Mining and Metallurgical Society of America in 1920, the Norwegian decoration of Knight Commander with Star of the Order of St. Olaf, and Chile's highest civilian honor, Knight Commander of the Order "Al Merito."

Proposed for Membership

Total AIME membership on Aug. 31, 1949, was 15,870; in addition 4424 Student Associates were enrolled.

ADMISSIONS COMMITTEE

James L. Head, Chairman; Albert J. Phillips, Vice-Chairman; George B. Corless, T. B. Counselman, Ivan A. Given, Robert L. Hallett, Richard D. Mollison, and John Sherman.

Institute members are urged to review this list as soon as the issue is received and immediately to wire the Secretary's office, night message collect, if objection is offered to the admission of any applicant. Details of the objection should follow by air mail. The Institute desires to extend its privileges to every person to whom it can be of service but does not desire to admit persons unless they are qualified.

In the following list C/S means change of status; R, reinstatement; M, Member; J, Junior Member; AM, Associate Member; S, Student Associate; F, Junior Foreign Affiliate.

ALABAMA

Birmingham—DONOHO, CHARLES KERR. (C/S—J-M). Chief metallurgist, American Cast Iron Pipe Co.

ARIZONA

Hayden—ELROD, SAM D. (C/S—S-J). Junior engineer, Kennecott Copper Corp.

Superior—PELLETIER, JOHN DAVID. (R, C/S—S-J). Geologist, Magma Copper Co.

Tucson — MARVIN, THOMAS CROCKETT. (C/S—J-M).

ARKANSAS

Fayetteville—MATTHAEI, RICHARD. (C/S—J-M). General superintendent, Corona Silica Corp.
Malvern—SACKETT, EARL L. H. (C/S—J-M). Assistant division metallurgist, Baroid sales division, National Lead Co.

CALIFORNIA

Berkeley—SMITH, EMORY. (M). Supervising engineer, California State Division, Industrial Safety.
Chino—SHAFER, ROBERT ROY. (C/S—S-J). Engineer in training, Stanolind Oil and Gas Co.
Long Beach—O'NEILL, DONALD BAILEY. (C/S—S-J). Engineer trainee, Shell Oil Co.
Los Angeles—CROG, RICHARD STANLEY. (C/S—J-M). Research group leader, Union Oil Co. of California. HAYASE, MASASHI. (C/S—S-J). STERLING, MORTON ALAN. (C/S—S-J). Petroleum engineer, Eagle Oil and Refining Co.
North Hollywood—CABEEN, WILLIAM ROSS. (C/S—J-M). Owner, William Ross Cabeen and Associates.
Ojai—McENTEE, JAMES ROBERT. (C/S—J-M). Senior mechanical engineer, Shell Oil Co.
San Francisco—GRAY, EDWARD GORDON. (C/S—AM-M). Project engineer, Goldfield Consolidated Mines. VER PLANCK, WILLIAM EVERETT, JR. (C/S—J-AM). Junior mining geologist, California Division of Mines.
San Marino — HOPKINS, JOHN. (M). District manager, Kobe, Inc.

COLORADO

Climax — FROHLING, EDWARD SEBASTIAN. (C/S—S-J). Metallurgical testing engineer, Climax Molybdenum Co.
Denver—BAKER, CROSBY FRED, JR. (C/S—J-M). Chief chemist and metallurgist, American Smelting and Refining Co.
Ouray—GRIGSBY, HARRY GORDON. (C/S—S-M). Mill operator, Idarado Mining Co.
Sargents — DUNN, JAMES EDWARD. (C/S—J-M). Superintendent, Callahan Zinc-Lead Co.
Silverton — ARCHIBALD, JOHN ELLIS. (M). Partner and mine manager, Lead Carbonate Mines, Inc.

CONNECTICUT

Milford—SNYDER, JOHN ALDEN. (C/S—J-M). Research metallurgist, Remington Arms Co.

GEORGIA

Atlanta—COFER, HARLAND ELBERT, JR. (C/S—S-J). Teacher, Emory University.

IDAHO

Burke—POWERS, PHILIP PHINEAS. (C/S—S-AM). Surveyor, Hecla Mining Co.
Kellogg—HARDY, ROBERT MONROE. (AM). Assistant treasurer, Sunshine Mining Co.

ILLINOIS

Berwyn — HRADECKY, FRANK JOSEPH. (M). Chief draftsman, Open Hearth Combustion Co.
Brookfield — GRAY, VERNON MAX. (C/S—S-AM). Cast-house metallurgist, Reynolds Metals Co.
Chicago—HATCH, GERALD GORDON. (C/S—S-J). Research metallurgist, Armour Research Foundation.
Clarendon Hills—DUNN, RAY P. (C/S—J-M). Plant metallurgist, Doehler-Jarvis Corp.
Evanston—ANDERSON, WALTER WILLARD. (R, C/S—JA-M). Technical director, Western Division, Commercial Testing and Engineering Co.
Mt. Vernon—POMEROY, CHESTER MITCHELL. (C/S—J-M). Technical representative, explosives, E. I. du Pont de Nemours and Co.

INDIANA

Evansville — INGLE, WILLIAM DAVIDSON, JR. (C/S—J-AM). Combustion engineer, Ingle Coal Corp.
Gary — NAULT, WILLIAM ALFRED. (C/S—J-M). Metallurgist, Carnegie-Illinois Steel Corp.
Whiting—GRAVES, DONALD B. (C/S—J-M). Physical metallurgist, Federated Metals division, American Smelting and Refining Co.

KANSAS

Baxter Springs—HOCKER, RICHARD LESLIE. (C/S—S-J). Field engineer, Amerada Petroleum Corp.
Belleville—ARROWSMITH, MURRAY REX. (C/S—S-J). Mining geologist.
Burden—MORRIS, SAM J., JR. (C/S—S-J). Area engineer, The Texas Co.
Eureka — ARNOLD, EDWIN S. (C/S—J-M). Assistant district superintendent, Phillips Petroleum Co. WITHERSPOON, PAUL ADAMS, JR. (C/S—J-M). Reservoir engineer, Phillips Petroleum Co.
Gorham—EHLERS, PETER LEE. (J). Junior petroleum engineer, Stanolind Oil and Gas Co.
Independence — LEE, THOMAS WILLIAM. (M). Production superintendent, Union Gas System, Inc.

KENTUCKY

Lexington — ROLL, WILLIAM HAYDEN. (M). Mining engineer, Department of Mines and Minerals, Commonwealth of Kentucky.
Wheelwright—KURTYKA, JOHN CHESTER. (R, C/S—S-M). Engineer, Inland Steel Co.

LOUISIANA

Hackberry — SIMPSON, JOHN MILTON. (C/S—S-J). Petroleum engineer, Stanolind Oil and Gas Co.
New Orleans — GRAHAM, WILLIAM JOSEPH. (C/S—S-J). Petroleum engineer trainee, The Texas Co.

MARYLAND

Baltimore—HAYES, SELDEN C. (C/S—J-M). Superintendent, heat treating and pickling, rustless division, Armco Steel Corp.

MASSACHUSETTS

Waltham—CLEVENGER, GALEN WILLIAM. (C/S—J-M). Senior metallurgist, Division of Industrial Co-operation, MIT.

MICHIGAN

Ann Arbor—LANDES, KENNETH KNIGHT. (R, C/S—JA-M). Chairman, department of geology, University of Michigan.
Detroit — KLAPKA, KARL JEROME. (C/S—J-M). Field engineer, Wheel Trueing Tool Co.
Ishpeming—AHL, WAYNE JOHN. (C/S—S-J). Mining engineer, Inland Steel Co.

MINNESOTA

Duluth — WILLIAMS, MILTON FRIEL, JR. (C/S—J-M). Associate chemical engineer, Oliver Iron Mining Co.
Hibbing—SMITH, DAVID POST. (C/S—S-J). Mining engineer trainee, Oliver Iron Mining Co.

MISSISSIPPI

Durant—MOORE, JOHN P. (C/S—S-J). Junior exploitation engineer, Shell Oil Co.

MISSOURI

Flat River—MARR, CHARLES A. (C/S—S-J). Mining engineer, St. Joseph Lead Co.

NEW MEXICO

Albuquerque — GRISWOLD, GILBERT RIPLEY. (C/S—J-M). Mining engineer, George W. Potter.
Fierro—YOUNG, THOMAS WESLEY. (C/S—J-M). Foreman, U. S. Smelting Refining and Mining Co.
Los Alamos—CAMPBELL, GILBERT LEWIS. (C/S—J-AM). Project librarian, Los Alamos Scientific Laboratory. TIPTON, CLYDE RAYMOND, JR. (C/S—J-M). Physical metallurgist, University of California, Los Alamos Scientific Laboratory.
Monument — BRAKEY, ROBERT JAMES, JR. (C/S—S-J). Field engineer, Amerada Petroleum Corp.
Silver City — RICHMOND, KENNETH CLYDE. (R, C/S—S-M). Engineer-contractor, self-employed.
Vanadium—GLADSTONE, IRVIN. (C/S—J-M). Chief geologist, Bayard division, U. S. Smelting Refining and Mining Co.

NEW JERSEY

Morristown—FINE, MORRIS EUGENE. (C/S—J-M). Member, technical staff, Bell Telephone Laboratories.
Westfield — DAHLSTROM, ROY. (M). Technical director, Titanium division, National Lead Co. LAGERGREN, MILTON ANDY. (C/S—J-M). Design engineer, American Smelting and Refining Co.

NEW YORK

Bayside—RUBENSTEIN, HENRY S. (C/S—S-J). Research engineer, Sylvania Electric Products, Inc.
Brooklyn — MITILINEOS, JOHN DIMITRIOS. (C/S—S-J). Metallurgical engineer, American Platinum Works.

Flushing — ARNAUT, ARNOLD DOUGLAS. (C/S—S-J). Junior engineer, Sylvania Electric Products, Inc.
Hicksville — RACEK, EDWARD WILLIAM. (C/S—S-J). Petroleum engineer, Acme Well Supply Co.
Lewiston—EVANS, FRED LEROY. (C/S—J-M). Plant superintendent, U. S. Vanadium Corp.
Long Island City — LUTTER, FRANK WILLIAM. (C/S—S-AM). Service engineer, Hardinge Co.
New York—CAMPBELL, JOHN BARDO. (C/S—S-J). Associate editor, **"Materials and Methods,"** Reinhold Publishing Corp. FREUDENTHAL, ALFRED MARTIN. (M). Professor of civil engineering, Columbia University. MORGAN, DAVID E. (C/S—J-M). Consulting engineer; vice-president, International Manufacturing and Equipment Co.
Port Washington—DeVINCENTIS, HAROLD ANTHONY. (C/S—J-M). Project leader, Sylvania Electric Products, Inc.

NORTH CAROLINA

Asheville—HASH, LEWIS JACKSON. (C/S—S-J). Geologist, Tennessee Valley Authority.

OHIO

Ashtabula — MICKSCH, JOSEPH ERNEST. (C/S—S-J). Research engineer, Lake City Malleable, Inc.
Canton—ROWLAND, ELBERT S. (C/S—J-M). Research metallurgical engineer, Timken Roller Bearing Co.
St. Clairsville—JOSLIN, RICHARD EDWIN. (R, C/S—M-AM). Preparation, Hanna Coal Co.
Cleveland—BALDWIN, WILLIAM MARCH, JR. (C/S—J-M). Research professor, Case Institute of Technology.
Columbus — MILLER, CARL EDWARD. (M). Technical advisor, Battelle Memorial Institute.
Martins Ferry—BALCAR, FRANK A. (C/S—J-M). General manager, B. B. R. Drilling Co.
Springfield—HELMAN, DONALD DEANE. (C/S—S-J). Chief metallurgist, Ohio Steel Foundry Co.
West Middletown—WESTFALL, E. R. (M). Superintendent, masonry department, Armco Steel Corp.
Youngstown — STEIGNER, EDWARD SAMUEL. (M). Tubular products development engineer, Youngstown Sheet and Tube Co.

OKLAHOMA

Shidler—BENZ, LEWIS WALTER. (M). Assistant district superintendent, Phillips Petroleum Co.
Tulsa—HAMNER, FRANCIS MERRICK. (AM). Geological engineer, Schermerhorn Oil Corp. SHERMAN, HENRY ALVORD. (M). Production manager, Schermerhorn Oil Corp. WENGER, EVERETT SAMUEL. (C/S—J-M). Petroleum engineer, Amerada Petroleum Corp. WILSON, RALPH HERBERT. (C/S—J-M). Field laboratory supervisor, Shell Oil Co. WOLFF, PAUL ANTHONY. (M). Consulting engineer, Barnsdall Research Corp.

OREGON

Albany—DILLING, ELMER DONALD. (C/S—J-M). Metallurgist, U. S. Bureau of Mines.
Maupin—ROE, JOSEPH THOMAS. (C/S—J-M). Construction engineer, Dantore division, Dant and Russell, Inc.

PENNSYLVANIA

Allentown—CONSTANTIN, GASTON FRANCOIS. (C/S—J-M). Research engineer, Fuller Co.
Beaver Falls—SHEPPARD, RALPH EDGAR. (C/S—S-J). Research engineer, St. Joseph Lead Co.
Bridgeville—MARTIN, ROBERT EDWARD. (R, C/S—S-J). Demonstrator, Cardox Corp.
Clarksville—KING, THOMAS ANTHONY. (C/S—S-J). Section foreman, Westmoreland Mining Co.
Cornwall — SLEEMAN, ROBERT WARREN. (R, C/S—S-J). Head engineer, Bethlehem Steel Co.
Dalton — ROTH, WILLIAM BELFORD. (C/S—S-J). Student engineer, Hudson Coal Co.
Easton — BLANCO CARRANZA, NESTOR, (J). Junior field geologist, Socony- Vacuum Oil Co. of Colombia.
Lebanon — LAMBERT, KENNETH ALFRED, JR. (R, C/S—S-J). Engineer, Bethlehem Steel Co. PEETS, ROBERT G. (C/S—J-M). Chief mining engineer, Cornwall division, Bethlehem Steel Co.
New Kensington — HOLLINGSWORTH, ERNEST HOWARD. (C/S—J-M). Research metallurgist, aluminum research laboratories, Aluminum Co. of America.
Pittsburgh — EDDINGER, RALPH TRACY (C/S—S-M). Chemical engineer, Pittsburgh Consolidated Coal Co. MERRILL, TIMOTHY WARRINGTON. (C/S — J-M). Metallurgical engineer, Vanadium Corp. of America. PELLISSIER, GEORGE EDWARD. (C/S—J-M). Research associate, supervisor, physical and analytical methods, research laboratory, Carnegie-Illinois Steel Corp.
Pottsville—INGERSOLL, DALLAS EAST. (R—M). Division superintendent, Philadelphia & Reading Coal and Iron Co.
Scranton — FOSTER, RALPH KEELER. (R, C/S—S-J). Service engineer, Ingersoll-Rand Co.
State College — FREDRICKSON, JAY WARREN. (C/S — S-AM). Chief, division of metallurgy, School of Mineral Industries, Pennsylvania State College.
Washington — LUCAS, EUGENE FREDERICK. (C/S—S-J). Metallurgical engineer and chairman of works committee, Molybdenum Corp. of America.

SOUTH CAROLINA

Greenville—KELLEY, JOSEPH A. (C/S—J-AM). Division manager, Zonolite Co.

TENNESSEE

Memphis — PHELAN, STEPHEN RICE. (C/S—J-M). Geological and geophysical engineer, Stephen R. Phelan.
Rockwood — LUDWIG, ROBERT LEE. (J). Associate metallurgist, NEPA projects, Fairchild Engine and Airplane Corp.

TEXAS

Alice — CHILDRESS, CHARLES OTTO. (C/S—S-J). Petroleum engineer, Magnolia Petroleum Co.
Andrews — VOGEL, ALFRED J. (C/S—S-J). Assistant superintendent, Fuhrman Petroleum Corp.
Austin—BEAN, ERNEST F., JR. (C/S—J-AM). Student, University of Texas.
Beaumont — CHANEY, PRESTON EARL. (C/S—J-M). Research engineer, Sun Oil Co. DIBRELL, ETHERIDGE. (R, C/S—J-M). Reservoir engineer, Sun Oil Co.
Bellaire—OLIVE, MARION DOYLE. (J). Petroleum engineer, J. R. Butler and Co.
Brownfield — GOODWIN, GENE MERREL. (C/S—S-J). Production engineer, Magnolia Petroleum Co. RHOADS, BENJAMIN JUDSON, JR. (J). Junior petroleum engineer, Stanolind Oil and Gas Co. ROWE, MARTIN DECATUR, JR. (C/S—S-J). Petroleum engineer, Magnolia Petroleum Co.
Conroe—NORTON, CHARLES A. (C/S—J-M). Field foreman, The Texas Co.
Corpus Christi—ALDRIDGE, EDWIN ERNEST, JR. (C/S—J-M). Senior production engineer, Pan American Production Co. NEAL, LESLIE RALPH, JR. (C/S—S-J). Junior petroleum engineer, La Gloria Corp.
Dallas — ELFRINK, ELLIOTT BAIRD. (J). Senior research engineer, Magnolia Petroleum Co. GRAHAM, GORDON LLOYD. (C/S—J-M). Petroleum engineer, DeGolyer and MacNaughton. KIMBLER, OSCAR KAVANAH. (J). Assistant chemical engineer, Atlantic Refining Co. PREHN, WALTER LAWRENCE, JR. (J). Associate chemical engineer, Atlantic Refining Co.
El Paso—PONSFORD, REGINALD GEORGE. (R—M). Partner, Ponsford-Moos Equipment Co.
Galveston—MANNING, JOHN ALBERT, JR. (C/S—S-J). Research engineer, Tin Processing Corp.
Houston—KASTROP, JULIAN EDWARD. (C/S—J-M). District editor, **World Oil**, Gulf Publishing Co. MEERS, ROBERT J. (C/S—J-AM). Division superintendent of drilling and production, Union Oil Co. of California. SMITH, HORACE VERNON. (C/S—J-M). General manager, Rolo Mfg. Co.
Irving—HURD, RAY MERLE. (J). Associate chemist, Atlantic Refining Co.
Laredo — CALOHAN, WILLIAM FRANK. (C/S—J-M). Consulting geologist.
Midland—SIMON, GERALD DAVE. (R, C/S—S-J). Petroleum engineer, The Texas Co.
Overton — BYRD, LAWRENCE HERMAN. (C/S—J-M). Assistant district superintendent, Humble Oil and Refining Co.
San Antonio—STAPP, WILFORD

LEE. (C/S—J-M). Petroleum geologist, Sunray Oil Corp.
Texas City—GEYER, ALVIN AUSLEY. (C/S—S-J). Roustabout engineer, Pan American Gas Co.
Victoria—DAVIS, JOHN ODUS. (C/S—S-AM). Petroleum engineer, Jergins Oil Co. of Texas.
Wickett—DAVIS, CHARLES EDWARD. (C/S—S-J). Field geologist, North Ward-Estes field, Texas, production division, Gulf Oil Corp.

UTAH
Cedar City—MADDOX, ROBERT DAVID. (C/S—J-M). Assistant mine engineer, Columbia Iron Mining Co.

VIRGINIA
Austinville—MOULD, CHANNING BENNETT. (C/S—S-J). Mining engineer, New Jersey Zinc Co.
Dante—COPELAND, ALFRED EUGENE. (C/S—S-J). Quality control engineer, Clinchfield Coal Corp.

WASHINGTON
Seattle—BAUER, WOLF GUNTHER. (M). Consulting engineer.

WEST VIRGINIA
Morgantown—FOWLER, CLEON ROSCOE. (C/S—S-M). Assistant superintendent, Christopher Coal Co.

WISCONSIN
Milwaukee—HUFFAKER, RAY EUGENE. (C/S—S-J). Metallurgical engineer, Ladish Co. IRVING, GORDON ERNEST. (C/S—S-J). Ore testing engineer, Allis-Chalmers Mfg. Co. MITCHELL, WILL, JR. (C/S—J-M). Director, basic industries research laboratory, Allis-Chalmers Mfg. Co.
Neshkoro—CODDINGTON, SAMUEL LEE. (C/S—S-J). Engineering trainee, Link-Belt Co.

WYOMING
Rock Springs—QUAY, JACK H. (C/S—AM-M). Engineer, Union Pacific Coal Co.

ALASKA
Anchorage—ARNELL, EDWARD LLOYD. (AM). Law partner, Plummer and Arnell.
Fairbanks—SAUNDERS, ROBERT H. (C/S—J-M). Surveyor, U. S. Smelting Refining and Mining Co.

ALBERTA
Edmonton—DOWNING, JOHN ARTHUR. (C/S—S-AM). Geologist, Bear Oil Co. LAKE, HAROLD EDGAR. (C/S—J-M). Mine superintendent, Eldorado Mining and Refining Co.

BRITISH COLUMBIA
Trail—JOHNSON, ROBERT. (C/S—S-J). Engineer in training, Consolidated Mining and Smelting Co. of Canada.

ONTARIO
Ottawa—GOUDGE, MONSON FRASER. (M). Chief, industrial minerals section, Bureau of Mines. McDONALD, ROGER DUNCAN. (C/S—S-J). Junior metallurgist (physical), Bureau of Mines, Ottawa.
Toronto—BULLEN, ROBERT LAWRENCE. (C/S—J-M). General superintendent, blue lead division, Canada Metal Co.

QUEBEC
Montreal—STEVENS, ROBERT WILLIAM. (C/S—J-M). Mining engineer, Dominion Engineering Works, Ltd.

CHIHUAHUA
Parral—BAKER, WILLIAM DAVIS. (C/S—S-M). Shift boss, American Smelting and Refining Co.

SONORA
Cananea—AGETON, ROBERT WILLIAM. (C/S—J-M). Engineer, Cananea Consolidated Copper Co.

ARGENTINA
Buenos Aires—MORAN, THOMAS GRAYSON. (C/S—J-M). Chief geologist, Damon Dinerman y Cia.

BOLIVIA
Oruro—PFEIFFER, ULRICH PAUL. (M). Metallurgist and mill foreman, Empresa Minera San Jose.

BRASIL
Rio de Janiero—DA SILVA, JAIR CARVALHO. (J). Tin plate division, National Steel Co. of Brasil.

CHILE
Rancagua—COLBERT, FRANK ANTHONY. (C/S—S-AM). Junior mine shift boss, Braden Copper Co.

COLOMBIA
Antioquia—BREEDING, WILLIAM HENRY. (C/S—J-M). Chief engineer, Pato Consolidated Gold Dredge, Ltd.

VENEZUELA
Caracas—HALL, MERLE LEROY, JR. (R, C/S—S-J). Field petroleum engineer, Texas Petroleum Co. LANDRETH, THOMAS CHART. (C/S—J-AM). Field engineer, Socony-Vacuum Oil Co. of Venezuela. SLOAN, C. CARLETON, (M). Production foreman, Socony-Vacuum Oil Co. of Venezuela.

ENGLAND
Port Talbot—KESTERTON, ARTHUR JOHN. (C/S—JFA-AM). Melting shop manager, Steel Co. of Wales.
Southport—PARK, CYRIL JOHN. (C/S—JFA-M). Director, William Park and Co., Forgemasters, Ltd.
London—HARRIS, EDWARD PERCIVAL. (M). Director and technical manager, H. J. Enthoven and Sons, Ltd.

FINLAND
Outokumpu—HAKAPAA, ERKKI ANTERO. (M). Mine superintendent, Outokumpu Co. HEIKKINEN, TIMO HENRIK. (M). Mill superintendent, Outokumpu Co.

FRANCE
Paris—KIMLER, COURTNEY WARREN. (R, C/S—JA-M). Sales engineer, ECA-OSR.

NORWAY
Oslo—ENGZELIUS, JOHAN GUSTAF. (M). Manager, Folldal Verk.
Sulitjelma—LANGE, JOHAN JOERGEN. (C/S—J-M). Assistant mill superintendent, Sulitjelma Mines.

SWEDEN
Surahammar—FORNANDER, SVEN GUNDE EDVIN. (C/S—JFA-M). Manager of research, Surahammars Bruks AB.

SOUTH AFRICA
Transvaal—McNEIL, ARCHIBALD. (M). Manager, Tweefontein United Collieries, Ltd.

INDIA
Bihar—NARAYANAN, PYLORE ISWARIYER ANANTHA. (M). Assistant director (ore dressing), National Metallurgical Laboratory, Tatanagar.
Bombay—RAJAGOPALASWAMY, KURMA. (M). Chief geologist, Associated Cement Companies.
Katni, C. P.—WILKS, ALAN DUDLEY. (C/S—JFA-M). Superintendent, ordnance factory, Government of India.

QUEENSLAND
Mount Isa—BURGER, DIONYS. (AM). Staff geologist, Mount Isa Mines, Ltd. HOSKING, PETER KAY. (J). Junior metallurgist, Mount Isa Mines, Ltd. PIKE, ARTHUR STANTON. (C/S—J-M). Assistant smelter superintendent, Mount Isa Mines, Ltd.

VICTORIA
Essendon—RANKIN, RALPH IAN. (C/S—J-M). Tunnelling superintendent, State Electricity Commission of Victoria.

WESTERN AUSTRALIA
Chandler—FITZGERALD, MARTIN LAURENCE. (M). Manager, State (W.A.) Alumite Industry.

NEW ZEALAND
Dunedin—PICKERING, BRUCE RAYMOND. (C/S—S-J). Underground mine worker, Blackwater Mines, Ltd.
Huntly—MARSHALL, THOMAS. (C/S—S-J). Metallurgist, Dominion Laboratory, D. S. I. R.

STUDENT ASSOCIATES
Elected September—1949

Lawrence Adler .. Columbia Univ.
Douglas Alexander ... Otago Univ.
Robert C. Carruthers .... MIT
Frank W. Cole ...... Univ. Okla.
Malcolm G. Coone .... Univ. Texas
Albert B. Cowan .... Univ. Texas
Jack P. Fly .... Univ. Texas
Gene W. Hinds ... Colo Sch. Mines
John P. Karshner..Colo. Sch. Mines
Philip L. McLaughlin.. Univ. Texas
Fred M. Lynch .... Univ. Texas
Francis L. Schulte ... Univ. Texas
John E. Shelton ...... Univ. Texas
William S. Shropshire..Univ. Texas
Allen I. Swartz .... MIT
Walter R. Williams .. Univ. Texas

What's New in Mining Safety

By J. J. FORBES* and S. H. ASH,* Member AIME

Introduction

Probably the newest thing in mining safety, or safety for mines, is the apparent dissatisfaction on the part of the mineral industries, as represented by both management and labor, and the general public of the Nation, with the safety record of the mining industry. This is reflected by published comments and papers in the technical press;[1–9] in labor periodicals,[10,11] in popular journals and periodicals,[12,13] and in the daily press; also by discussions of the Safety Committees sponsored by the National Safety Council,[9,14–15] the American Mining Congress,[1,16] the American Institute of Mining and Metallurgical Engineers,[3,4] the Mine Inspectors' Institute of America,[6,8,17,18] the Coal Mining Institute of America,[5,19] the American Standards Association, and others.[20,21]

Mining safety is a joint problem of management and the individual workman. Safety is not attained and will not be attained solely by laws, decrees, and commands because, if it could be done in this manner, acceptable mining safety would have been achieved long ago by the individual states in our Nation and by the nations abroad. The best safety performance is found at plants where management provides a safe environment for the workers; where supervision is efficient and supervisors, others concerned with promoting safety, and the individual worker know through training, experience, and personal contact the safe and unsafe practices of their field; and where the trained individual worker has become safety-minded by experience, quiet influence, unconscious suggestion, and personal guidance.

Despite what may be said to the contrary, progress has been and is being made in mining safety.[22–27] This is shown in Fig 1 to 4.

It is beyond the scope of this paper to give possible reasons for the valleys and peaks in the fatal-injury rates. Some recent factors that appear to be contributing to the improvement in these rates are briefly discussed.

Aside from mining equipment, "what's new in mining safety" for some mines has been in effect or was tried by others long ago. A safety program is a living thing; as such, it must be vitalized and continuously fed with enthusiasm, constructive action, and improvements. Because safety is concerned with human conduct, it is necessary to practice safety at all times; if not, it is soon forgotten, and accidents occur.

San Francisco Meeting, February 1949.

TP 2663 A. Discussion of this paper (2 copies) may be sent to *Transactions* AIME before Nov. 30, 1949. Manuscript received Jan. 28, 1949.

* Chief, Health and Safety Division, and Chief, Safety Branch, respectively, U. S. Bureau of Mines, Washington, D. C.

[1] References are at the end of the paper.

Mining-safety Records

The large employment and production concerned with anthracite contribute much to the mining-safety records of the mineral industry. Approximately 81,000 persons are employed in this industry having mines concentrated in an area of 480 square miles in northeastern Pennsylvania. Because of the achievement of the anthracite industry in safety during 1948, the other branches of the mineral industry can profit by a study of what has been done to achieve that record. Where one mineral is produced by other large groups having methods of mining that are similar in many respects to the anthracite-mining methods, an achievement in such a large industry is important.

Salient factors concerned with safety in the anthracite industry are: no radical change has occurred in the mining-safety regulations pertaining to anthracite mines. Because anthracite mining is a branch of the coal-mining industry,

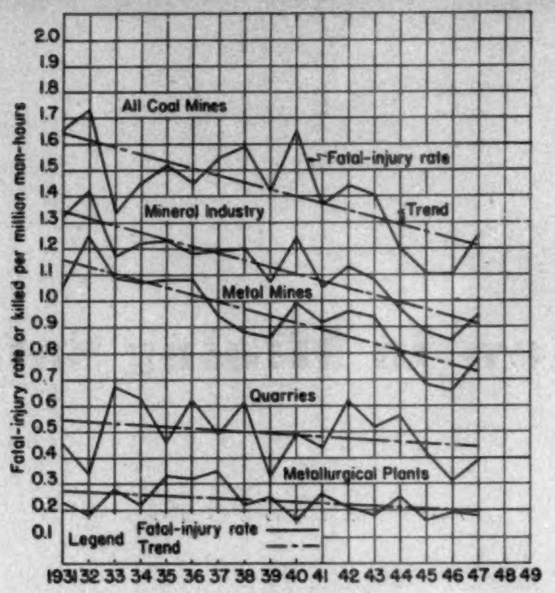


FIG 1—Fatal-injury rates and trends for mineral industry and its branches, 1931–1947.

it is important to know that the Federal code applying to bituminous-coal and lignite mines does not apply to anthracite mines; however, the anthracite industry and the United Mine Workers of America have made safety a part of the Joint Wage Agreement, and a health and welfare provision similar to that applying to bituminous-coal and lignite mines is included. These factors are new.

Moreover, it appears that, coupled with the foregoing factors, a monthly circular letter[27] from Joseph J. Walsh, Deputy Secretary of Mines, Pennsylvania, to all anthracite mine inspectors, mine officials, and miners has made a substantial contribution to the 1948 safety record of this industry.

Since mining began, the roof-fall hazard has been recognized as the No. 1 hazard in coal and noncoal mining. It still remains as such and is also the most difficult one to guard against.

By concentrating on this hazard, all concerned with safety in the anthracite industry have contributed the lowest annual fatality rate per million man-hours in the history of coal mining. This rate is 0.85. Of the 360 anthracite-mining companies, 320 had no fatalities for the 12-month period January to December 1948.[27] This record is new to coal-mining safety in the Nation. Because the improvement in the safety record is substantially the result of preventing injuries from falls of roof, and because available information on roof-fall injuries for the entire mining industry shows an upward trend for 1948, the anthracite record is significant.

NEW ACTION PROGRAMS AFFECTING MINING SAFETY

It is beyond the scope of this report even to mention safety programs and records of individual companies or mines;[4,28] likewise, it is not the purpose of this paper to point out poor safety records.

Because employment in bituminous-coal mining composes approximately 70 pct of the man-hours of exposure for the mineral industry, any safety program concerning the bituminous-coal-mining industry materially affects the fatal-injury rate and the severity rate of injuries for the mineral industry as a whole.[24]

It has long been recognized that voluntary employee cooperation and compliance with safety rules are indispensable requisites to improve the mining-safety record; moreover, experience has proved that where an industry acts as a unit to improve safety, the record improves.

The idea of making the promotion of safety in and about mines a responsibility to be shared equally by the employees and the management is not new. Neither is the idea new that this may be attained by law, because in March 1927 the legislature of the State of Washington passed laws that supplemented their code of mining laws and provided that safety committees (Sections 222–25, incl., 227, and 228, Chapter 306, Laws of Washington) be selected by management and labor to function at the coal mines of the State.[29] The foregoing code for mining safety by law resulted from action and agreement between the coal-mining industry and the United Mine Workers of America in the State of Washington

The idea of promoting safety in an industry by "wage agreement" is new and is typified by the inclusion of safety as part of the wage agreements both for the bituminous-coal and lignite mines of the United States and for the anthracite operators of Pennsylvania, and the United Mine Workers of America.

Because of the significant effect of employment on the injury rates for the mineral industry, salient points relating to safety in the bituminous-coal-mine agreement are found in a paper[5] given on Dec. 10, 1948, by C. F. Davis, Director of Safety, United Mine Workers of America, before the Coal Mining Institute of America:

> There is nothing new or revolutionary in the safety program of the United Mine Workers of America. Throughout the history of the miners' union, one of the chief objectives has been better mining laws, the enforcement of such laws when enacted, better and more competent supervision, and greater safety for men employed in the industry.
>
> For years we have realized that a comprehensive National Safety Program by our union was impossible unless Federal legislation was passed which would allow one set of rules, and a system of inspection that was uniform in all coal-producing areas. We have, therefore, consistently pressed for Federal legislation which would bring this about.
>
> The enactment of Public Law 49 by the 77th Congress,[30] providing for the setting up of standards and the inspection of coal mines by Federal mine inspectors, with written reports of such inspections to be sent to the company owning the mine, the mining department of the State in which the mine is located and the labor union (if any) having a contract at the mine, brought this program closer to realization. However, the fact that the law carried no enforcement provisions has hampered the mine workers in completely carrying out the objectives of the union.
>
> The Wage Agreement of 1941 carried a provision for mine safety committee-

men, but their activities were restricted by the fact that recommendations of Federal mine inspectors were only advisory. State mining departments generally were noncooperative and coal companies in many instances were hostile to the idea.

This situation was greatly improved by an agreement entered into by Mr. John L. Lewis, President of the United Mine Workers of America, and Mr. Krug, Secretary of the Interior, representing the President of the United States, which provided for the setting up of a code of safety standards and their enforcement during the period of Government operation.

With the end of Government possession, the Federal mine safety code was made a part of the Joint Wage Agreement, and recognized nationally by both parties to the agreement as being the minimum safety requirements necessary to the industry, in the following language:

(A) *Mine Safety Code*

The Federal mine safety code[31] for bituminous coal and lignite mines of the United States, adopted pursuant to an agreement dated May 29, 1946, between the Secretary of the Interior and the President of the United Mine Workers of America and promulgated July 24, 1946, is hereby adopted and incorporated by reference in this contract as a code for health and safety in bituminous and lignite mines of the parties of the first part, with the following exceptions and alterations:

(1) The opening paragraph beginning with the words "pursuant to" and ending with the words "executive order" is stricken out.
(2) The words "coal mines administrator" are stricken out wherever they appear.
(3) Sections 5(a) and 5(b) of Article XII and all of Article XIV are stricken out.
(4) References in the code to its effective date shall be deemed to refer to the effective date of this contract.

(B) *Enforcement*

(1) Reports of Federal coal mine inspectors:—Wherever inspectors of the Federal Bureau of Mines, in making their inspections in accordance with authority as provided in Public Law 49, 77th Congress, find that there are violations of this code and make recommendations for the elimination of such noncompliance, the operators shall promptly comply with such recommendations, except as modified in paragraph two of this subdivision (B).
(2) Whenever either party to the contract feels that compliance with the recommendations of the Federal mine inspectors as provided above would cause irreparable damage or great injustice, they may appeal such recommendation to the joint board of review as hereinafter provided.

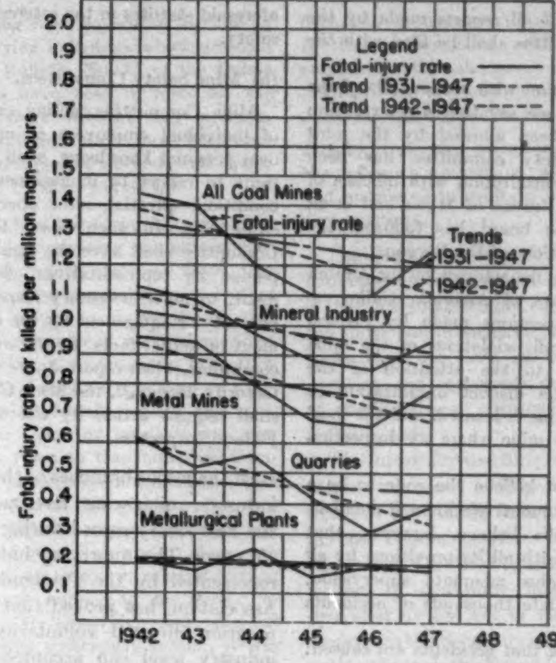


FIG 2—Fatal-injury rates and trends for mineral industry and its branches, 1942–1947, with 1931–1947 trends for comparison.

(C) *Review and Revision*

In order to carry out the intent and purposes of the agreement affecting the mine safety code, it is agreed that from time to time joint consultations shall be had with the U. S. Bureau of Mines looking toward review and appropriate revision of the mine safety code.

(D) *Joint Industry Safety Committee*

There is hereby established under this agreement a joint industry safety committee composed of four members, two of whom will be appointed by the mine workers and two of whom will be appointed by the operators, whose duty it shall be to (1) arbitrate any appeal which is filed with it by any operator or any mine worker who feels that any reported violation of the code and recommendations of compliance by a Federal coal mine inspector has not been justly reported or that the action required of him to correct the violation would subject him to irreparable damage or great injustice: and (2) to consult with the U. S. Bureau of Mines in accordance with the provisions of section (C) above.

(E) *Mine Safety Committee*

At each mine there shall be a mine safety committee selected by the local union. The committee members while engaged in the performance of their duties shall be paid by the union, but shall be deemed to be acting within the scope of their employment in the mine within the meaning of the Workmen's Compensation Law of the State where such duties are performed.

The mine safety committee may inspect any mine development or equipment used in producing coal. If the committee believes conditions found endanger the life and bodies of the mine workers, it shall report its finding and recommendations to the management. In those special instances where the committee believes an immediate danger exists and the committee recommends that the management remove all mine workers from the unsafe area, the operator is required to follow the recommendations of the committee.

If the safety committee in closing down an unsafe area acts arbitrarily and capriciously, members of such committee may be removed from the committee. Grievances that may arise as a result of a request for removal of a member of the safety committee under this section shall be handled in accordance with the provisions providing for settlement of disputes.

The safety committee and operators shall maintain such records concerning inspections, findings, recommendations, and actions relating to this provision of the agreement as may be required,

and copies of all reports made by the safety committee shall be filed with the operators.

In connection with section (D) of the contract let me say that any exception which has been allowed by the joint industry safety committee has been done after consultation with officials of the Federal Bureau of Mines and in all instances the board has followed the recommendations of the Bureau.

The safety department of the United Mine Workers of America studies reports of inspections made by Federal inspectors, calls violations of the mine safety code to the attention of the company, the district organization in which the mine is located, and the local union at the mine where the inspection was made.

We do not believe the code to be a perfect instrument. We know it could be improved. We believe, however, that compliance with all its provisions by all concerned, plus adequate supervision, would eliminate thousands of accidents each year.

We believe that accidents are caused; that they are the result of many contributing factors focused to a given point at a particular time; that the time to avoid accidents is before they happen, by eliminating the contributing factors.

We believe that the elimination of recognized hazards from the industry plus intelligent cooperation by all concerned could make the occupation of coal mining one of the safest in the Nation. Our entire efforts are directed at bringing this about.

The following provisions are abstracted from the Anthracite Wage Agreement between the International Union and Districts 1, 7, and 9, United Mine Workers of America, and the anthracite operators:

Mine Safety Program

(a) Federal Mine Safety Standards.

Inspectors of the Federal Bureau of Mines shall make periodic investigations of the mines, and report to the mine management and the United Mine Workers of America any violations of the Federal Safety Standards.[33]

Operators and Mine Workers agree to accept such standards of safety adaptable and practical to the anthracite industry, subject, however, to the right of review by the Director of the United States Bureau of Mines, upon petition from the Operator or the United Mine Workers of America. The right of review shall not delay taking of necessary steps to correct unsafe conditions where the immediate safety of men is involved.

Nothing herein shall operate to nullify existing State statutes, but this Agreement is intended to supplement the aforesaid statutes in the interest of mine safety.

(b) Mine Safety Committees.

Mine Committees, acting on request of individual employees or upon their own personal knowledge, shall have the right to report to management unsafe conditions affecting mine operations or equipment. In such cases the Mine Committee shall have the right, accompanied by representatives of management, to make necessary inspections of property or equipment for the ascertainment of actual facts. In the event such conditions, when reported, are not satisfactorily corrected, the Mine Committee shall request action by the State and Federal Inspectors.

Of the major branches of the mineral industry, quarrying has maintained the best safety record during the past 17 years. The quarrying industry, as represented by the Portland Cement Association, has proved that a safety program directed voluntarily on the industry level can accomplish much more than sporadic attempts by units of the industry throughout the United States.

An attempt, which is new, in a similar direction has been started by the National Coal Association's establishment of a Safety Division in February 1948, with the object of stimulating further interest in accident prevention among the member bituminous-coal-mining companies and the bituminous-coal industry as a whole.[19] The methods used by the association to achieve better safety are: (1) intimate contact by visitation with the heads of the producing companies and the men in charge of safety work; (2) acting as liaison between the member companies to disseminate information of methods and materials found to be successful in the individual companies for the use of all companies; and (3) sponsoring programs of accident prevention in the bituminous industry throughout the United States.

The National Coal Association believes that, through educational work as presented by the Federal Bureau of Mines in its first-aid and mine rescue training and accident-prevention classes for men and officials, much good can be accomplished.

Mining-safety Regulations

Mining-safety regulations in force in the United States can be divided into two general classes: mining-safety laws and mining-safety orders.

Changes in mining-safety laws are a slow process inherent in the procedure by which laws are made. Because mining-safety laws are changed with difficulty, it usually requires an aroused public opinion following a disaster to change them; this, coupled with the

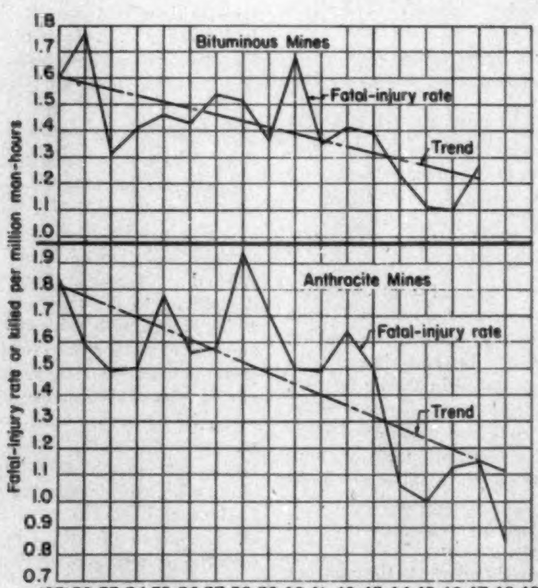


FIG 3—Fatal-injury rates and trends for bituminous-coal mines, 1931–1947, and for anthracite mines, 1931–1948.

resistance to change, as much as anything else is responsible for much of the dissatisfaction with many of our coal-mining-safety laws. On the other hand, mining-safety orders that have the effect of law can be changed in a satisfactory manner to meet changing conditions, new equipment, and progress. In general, the coal-mining states have laws; whereas, regulations pertaining to noncoal mines find more favor as orders.

Recent important changes in state coal-mining laws in Pennsylvania, Kentucky, Illinois, and Arkansas are discussed in detail elsewhere.[33] The changes in these laws are designed to prevent mine disasters.

A recent important change in mining-safety orders that is of interest to noncoal mining is for the State of New York which, in 1948, revised the Industrial Code relating to underground mining operations.[34] Those interested in mining-safety codes that are neither too cumbersome nor inequitable can well afford to study the process by which the Industrial Code in force for 28 years in this state is changed. The following "Foreword" appearing in the copy issued for "public critical review" is of interest:

The existing rules governing the mining and quarrying industries which are contained in Bulletin No. 17 of the Industrial Code have been in force for the past 28 years without any revision. During that time there have been considerable changes in methods and equipment used by these industries.

Therefore, the Industrial Commissioner appointed an advisory committee consisting of representatives from the underground mining industry and other interested groups to review the existing rules and recommend such changes as they may deem necessary to bring this part of the Industrial Code up to date. After a series of conferences of this committee the following proposal was presented by them to the Industrial Commissioner as their recommendation. Their first proposal is to separate the two distinctly different subjects, underground mining and quarrying, and to place each under a separate cover; rules governing underground mining to be known as Rule No. 31. Quarrying and open-cut mining being sufficiently similar, it was deemed advisable to place these subjects under another separate cover.

The committee next proposed the elimination of obsolete rules such as those pertaining to animal haulage and open-flame permanent lighting, while proposed additions and revisions consisted of extensive changes in and additions to the entire code with particular emphasis on the rules governing electrical installations, use and handling of explosives, hoisting and haulage.

Finally, the rules as recommended by the advisory committee were grouped and numbered to conform with present-day practices.

The mining-safety laws of the Province of Ontario, Canada, were revised in 1948.[35] This code is one of the most comprehensive metal-mining codes that has been issued in North America and represents careful study of methods and equipment used in metal mines.

The most far-reaching endeavor to attain increased safety in the coal mines of the United States is embodied in the Federal system of coal-mine inspection. On May 7, 1941, a Federal system of coal-mine inspection was provided by an Act of Congress that empowers the Secretary of the Interior, acting through the Bureau of Mines, to "make or cause to be made annual or necessary inspections and investigations in coal mines the products of which regularly enter commerce or the operations of which substantially affect commerce."[30,36] The purpose of such inspections and investigations is to obtain information relating to health and safety conditions, to accidents causing bodily injury or loss of life, and to causes of occupational diseases originating in the coal mines of the United States.

Standards and rules pertaining to safety conditions and practices in bituminous-coal and lignite mines in the United States are embodied in the Federal Mine Safety Code.[31] This code is utilized by the Federal coal-mine inspectors for conducting inspections in bituminous-coal and lignite mines.

Federal Safety Standards,[32] applicable to anthracite mines, are utilized by Federal coal-mine inspectors when inspecting anthracite mines.

The Bureau of Mines administers the act through the Coal-Mine Inspection Branch, Health and Safety Division.[36] For the year 1948, funds were appropriated to employ a staff of 250 inspectors of various grades, 25 mining engineers, 5 mining-electrical engineers, 5 mining-explosives engineers, and 75 clerical assistants.

On appointment, new inspectors are trained at the Central Experiment Station of the Bureau of Mines, Pittsburgh, Pa. The training course comprises Code requirements, techni-

FIG 4—Fatal-injury rates and trends for bituminous-coal mines, 1942–1947, and for anthracite mines, 1942–1948, with 1931–1947 and 1931–1948 trends for comparison.

cal mine-safety subjects, mine rescue, first aid, inspection procedures, and safety organization.

Between 6000 and 7000 coal mines in the United States operate throughout the year, and approximately the same number produce coal in small quantities sometime during the year. Nearly 2500 of the continuously operating mines employ more than 25 persons each, and it was to these mines that the efforts of the Federal inspectors were directed first. Increases in the number of inspectors in 1947 and in 1948 have made possible the inspection of many of the small mines and more regular inspection of larger ones.

Cooperation is maintained between Federal and State inspectors.

In addition to their ordinary inspection duties, the Federal coal-mine inspectors address safety meetings of mine workers, write papers on safety subjects for publication, and undertake special investigations concerning particular hazards.

Research

Through observation and study of existent mining methods, of causes of accidents, of methods utilized in other industries doing similar tasks, and of the effects of injuries on the morale of workers and on the efficiency of the plant, researchers with ideas, open minds, and something to work with and strive for can find safer, easier, and cheaper ways of doing the job of modern mining.

Mass production of our mineral resources has required mass-production methods that, though increasing production, have created new hazards and, at the same time, removed others. Anything that will save labor, whether it is equipment or methods, can reduce injuries in mining. Borcherdt[37] has explained in detail the role of research in the development of new labor-saving equipment and methods.

Research that affects mining is both development and applied research. Pure research that may never reach the development and applied stages is necessary, and it is new to observe that segments of the mining industry are energetically putting the right foot forward in research.[1,7,10,17,25,26,37–42]

Remedies have been applied over the years to prevent injuries from falls of roof, which is the major cause of injuries in all branches of mining. More efficient supervision of the working faces,[18] systematic timbering,[43] and procedures for roof testing have been discussed time and again. It is obvious that the mining industry as a whole has not, as yet, found the proper remedy.[7,44,45]

Curzon[39] describes a research program comprising changing mining methods and blasting practices at the Holden mine[46] in recent years that has had a decided effect on preventing roof-fall injuries. Helms and others[47] describe research on the methods of large-scale stripping of steeply dipping beds in Pennsylvania's anthracite region. This, by reducing underground mining, has contributed materially to fewer roof-fall injuries in mining anthracite.

Thomas and others[17,45] have conducted research on the use of steel cross bars bolted to the roof or supported by pins in the ribs, as practiced in some metal mines. This has now been adopted in both coal and metal mines and is being tried in others.

In connection with size, spacing, and removal of pillars, research is now being conducted at Rifle, Colo., by the Bureau of Mines to determine the maximum safe width of rooms. Obert and Duvall[48] are conducting tests in mines in the iron ranges to detect overloads on pillars by use of recording geophones. This contributes knowledge on rock bursts.

Research is being conducted by the Bureau of Mines, the General Reinsurance Corp., and the Mine Safety Appliances Co., on a new electronic roof-testing device. Indications are encouraging, in that this method of roof testing will be applicable to coal roof as well as to all other types of mine roof and that this new method of testing eventually will give the mining industry a practicable and positive means of determining roof conditions and will thus reduce the hazard to which most mining fatalities can now be attributed. Continuance of this research should very definitely contribute to the solution of the problem of obtaining adequate mine-roof detection.

A large percentage of explosives manufactured in the United States are utilized by the mineral industry. Hazards to life and property are present when explosives are used for mining. Bickel[15] has recently described blasting hazards in metal mines, and research conducted to obviate such hazards.

During 1946 to 1947, research was conducted in some large coal mines in the State of Washington by representatives of the State Mine-Inspection Department, the mining companies, the explosives companies, and the Bureau of Mines on the use of fast-delay electric blasting caps. It was found that safer and more efficient blasting is obtained when compared with any other system of single-shot or multiple blasting.

Observations concerning fast-delay electric blasting caps are: fast-delay or millisecond electric blasting caps, introduced over 3 years ago, fire individually but in such small time relation to each other that the action of certain charges supplements the action of other charges before there has been any appreciable movement of the burden or release of gases from behind the burden. Whereas regular-delay electric blasting caps have intervals between firing periods that are measured in seconds and single-shot blasting necessitates intervals between firing periods measured in minutes, the fast delays are measured in milli- or thousandths of seconds. Although the firing of individual regular delays in a series is perceptible to the ear, that of the millisecond delays is too rapid for reliable perception. Such small intervals may best be recorded with some form of electrical timing device.[49]

When fast-delay electric blasting caps are used in burden that is not broken up by cracks and fissures that would permit the gases of the explosion to escape before they have done their useful work, better fragmentation, reduced back break, less vibration, less smoke, reduced explosive gas, less dust, and controlled throw are attained.

Research on explosives by the Bureau of Mines is continuous. More than 1600 tests have been made on permissible explosives, blasting devices, special types of explosives, detonators, and hazardous chemicals. Tests included the effects of sheaths on gaseous products from permissible explosives, the effect of oxygen balance of explosives on gaseous products, the explosion hazards of perchloric acid and mixtures with organic materials, and ignition hazards of mixtures containing ammonium nitrate.

The Bureau of Mines has approved explosives and blasting units classed as permissible since 1909 (explosives) and 1924 (blasting units).[50,51] Because of improvements in explosives, on July 20, 1946, the Bureau approved both the extension of the 1½ lb limit for using permissible explosives to a 3 lb limit and the use of permissible multi-

ple-shot blasting units.[52]

Research has been conducted by the Bureau of Mines in the laboratory and in the field on diesel-powered locomotives and engines.[53,54] Information has been obtained on the quantity of harmful and objectionable gases produced by diesel engines and on the hazards of operating them in normal atmospheres and in explosive atmospheres. Methods to prevent ignition of explosive atmospheres were determined. A schedule of requirements that must be met by diesel locomotives that are permissible for safe use in coal mines was formulated in 1944, and in 1948 a schedule was prepared on their use in mines where explosive gases are not encountered. Future work contemplates research on methods to condition the exhaust gas so as to minimize the discharge of harmful exhaust gases.

In cooperation with manufacturers and mine operators the Bureau of Mines has participated in the design and development of new coal-mining equipment to meet difficult and unusual mining conditions, to increase safety, and to conserve coal. Shearing machines and coal planers in connection with loading units have been tested successfully. Utilization of such machines can reduce numerous hazards at the faces.[55,56]

A new continuous mining machine, which combines the operations of cutting, drilling, shooting, and loading, was introduced to industry by the Sunnyhill Coal Co., at its plant in New Lexington, Ohio, on Oct. 27, 1948. Although the company feels that the machine has demonstrated its practicability, they still regard it as somewhat in the development stage as far as actual operating methods are concerned.[38] Another continuous mining machine, developed by the Joy Manufacturing Co., was introduced to industry on Dec. 15, 1948, in the Mathies mine of the Pittsburgh Coal Co., Finleyville, Pa.[10]

Boreholes of different diameters for connecting advance workings to the surface for ventilation, communication, prospecting, power circuits, and escapeways have solved problems in safety and development. Originally used in metal and other noncoal mines, they are being found useful in coal mining where the depth is not too great. The boreholes range from 6 to 48 in. in diameter, the larger ones often fitted with a hoist and man cage.[57–59]

A recent example at a coal mine is an escape shaft 48 in. in diameter and 200 ft deep. The shaft serves as an outlet for return air, 50,000 cu ft a minute being exhausted. A steel cage for six men is operated by a gasoline-powered hoist. Telephone communication is installed.

Investigations of the utilization of radio for communication underground have been continued at intervals since 1920. Recent experiments indicate voice communication by radio through soil and strata is feasible and may be applied in some normal mine operations. The problem requires further investigation and adaptation of equipment, but the results so far are encouraging.[60,61]

Haulage accidents comprise the second large group of mine accidents. Haulage jobs are the most dangerous class in mining. Despite these facts, haulage looms very large as needing effective action in mining safety.

Despite numerous safety devices and research conducted to find a positive dependable safety device to prevent disasters by falling cages and cars, disasters happen from time to time. Because of the Paymaster mine accident on Feb. 22, 1945, when 16 men were killed when the hoisting cable failed, the most comprehensive research program regarding hoisting equipment and hoisting practice ever conducted in America was made for Ontario mines by a committee appointed by the Province of Ontario. The report of this committee in 1947[62] is an invaluable contribution on the foregoing subject.

Mining-safety research is a problem throughout the world and, after a lapse of 7 years, the Fifth International Conference of Directors of Mine-Safety Research was held at Pittsburgh, Pa., on Sept. 20–25, 1948. Representatives from Great Britain, Belgium, France, Germany, Poland, and the United States participated in the program, covering subjects on mining safety.[63]

Research on means of reducing the hazards of coal-mine explosions is continuous by the Bureau of Mines. Many existent methods are improved and new ones developed. The utility of different materials and methods for extinguishing mine fires is investigated. Studies are continuous on the mechanism of ignition, propagation of flame, and flame quenching to further protect against ignition of explosive gas in mines.[60,63–65]

Safety Education

There are as many different opinions regarding what constitutes safety education as there are as to what constitutes good supervision. An effective program of safety education must not only focus the attention of the workmen and officials on accident prevention, but it must also secure their interest and desire to do everything possible to prevent accidents, or the program is doomed to failure.

Auburn[14] has ably explained that the employee is the focal point in the prevention of accidents and that an accident-prevention program must be planned around him.

The Coal Division of the American Mining Congress has set up a program on safety education.[1]

The part that job training must play and can accomplish in safety education is more recently proved by job-training programs that get results in widely separated localities.[14,16,60,66–69]

Accident-prevention courses of the Federal Bureau of Mines are available for supervisors and workmen alike to become familiar with the store of mine-safety technology that has been developed and accumulated by this Bureau through its close contact with safety problems of the mineral industry during the 38 years of the Bureau's existence.

The text of the course for bituminous-coal mines covers the subjects of accident statistics; falls of roof and coal; hoisting and haulage; explosions and fires; explosives; electricity; and miscellaneous hazards. The course is published as Miners' Circulars 47 to 50, and 58 to 60.

The text of the course for metal mines covers the subjects of accident statistics, falls of rock or ore; hoisting and haulage; explosives; fires, gases, and ventilation; electrical and mechanical hazards; and health and miscellaneous hazards. The course is published as Miners' Circulars 51 to 57.

A similar course is prepared and given for the petroleum industry. Following research begun in 1932 and ended in 1947, a bulletin[70] on safety practices in dredging and hydraulic mining has been published and constitutes a text for this branch of mining.

Research is being conducted by the Bureau at smelters, refineries, and processing plants so as to obtain information to serve as an accident-prevention course for the metallurgical industry.

Copies of the above-mentioned publications are given free to all persons who enroll in the respective courses.

The Bureau's courses are based upon general conditions found in the mineral industry, and broad phases of safety are discussed in general terms. Safety and production are closely related, and the courses are designed to bring the two into proper focus.

The successful instructors of these courses are experienced engineers who devote most of their time and discussions to the particular conditions found in the mine or plant where the class is being conducted.

In addition to the miners' circulars previously mentioned, the Bureau of Mines has made available other facilities to assist the instructors in presenting the course. Numerous lantern slides have been prepared from mining photographs, diagrams, and maps illustrating various topics in the course, and each instructor has a complete set with a slide projector for displaying them.

This store of visual educational aids is augmented from time to time by the addition of slides depicting up-to-date developments in mining. Each instructor is provided with a gas-explosion gallery in which he can demonstrate the ignition of methane by arcs and sparks, as well as the effect of black damp or low oxygen content in methane-air or other gas-air mixtures. A coal-dust explosion gallery has been provided for each instructor to demonstrate both the explosibility of bituminous-coal dust and the effect of rock dust in preventing the ignition of coal dust and propagation of flame. Each instructor has equipment useful for class-demonstration purposes.

To date only a small percentage of the total number of persons employed in the mineral industry has been given these courses; but the number of courses conducted each year is increasing, and requests for repetitions of the courses are indicative of interest in them. A certificate is awarded by the Bureau of Mines to all persons who complete the course of training.

After 40 years of continuous effort to decrease accidents in the mineral industry, the Bureau of Mines continues to believe that first-aid training is the best foundation upon which a safety program can be built. For nearly 15 years before World War II, approximately 10 pct of the total number of persons employed in the mineral industry were trained annually through a cooperative program of mining companies and the Bureau of Mines. During the war, first-aid training was neglected for what appeared to be good reasons at the time, and for two years (1945 to 1946) only 2 pct of the total number of persons employed in the mineral industries were given first-aid training.

The demands from the mineral industry for more intensive first-aid training of personnel has led to development of a new phase of cooperative training. Most operating companies have in their employ qualified first-aid instructors whose ability to teach has been well-demonstrated. These instructors now bear the brunt of the work and are responsible to their employers and the Bureau of Mines for maintaining a standard of teaching worthy of a Bureau of Mines certificate.

Under the foregoing program, the limited personnel of the Bureau is able to supervise and assist in the training of a much greater number of men than could otherwise be possible. The number of persons trained in first aid has doubled in the last two years; and it is expected that, with the growth of this type of training, the usefulness of Bureau personnel can be extended as never before. Men holding Bureau of Mines first-aid certificates develop a sense of belonging to an organization that is seriously dedicated to the prevention of accidents. If a sense of safety-consciousness can be embedded and maintained in each worker, the number of accidents will be decreased.

Conclusion

The battleground for the world today is at the worker level.[71] The battleground for mining safety has always been at the worker level, and so we need among our leaders for mining safety men and women who know our mining people best and are closest to them. Safety trends to the degree that this fundamental fact is recognized in action programs.

Just as long as mine workers are expected to continue to use individual judgment on methods of doing work, and those charged with responsibility for mining safety endeavor to fix responsibility for accidents either on the implied carelessness of the worker rather than enlist his services in action programs or on the implied callousness of the employer, improvement in mining safety will lag. Furthermore, because a worker today may become an immediate supervisor tomorrow, the safety-consciousness inherent in this worker will be that on which he, as a supervisor, must grow.

Improvement in mining safety is evident in those plants and branches of the mineral industry where the workers are an integral part of the safety program.

Labor leaders can bring special equipment to an assignment like mining safety. They are used to dealing with people.[71] Unions must support all constructive efforts to prevent accidents. They must, where it is indicated, side with management in the correction of faults of the worker for his own safety.[14]

The improvement in mining safety lies with the industry. Something must be done to get the attention of the worker in mining safety, create his interest in it, and maintain a firm desire on his part to practice safety. The worker and supervisor alike must realize and believe that the worker is the focal point in the prevention of accidents.

References

1. Annual Conference of the Coal Division. Reports on Important Operating Phases of Coal Mining. *Min. Cong. Jnl.* (Dec. 1948) 34, (12) 53–56.
2. Better But Still Bad. *Min. and Met.* (Sept. 1948) 29 (501) 501.
3. Better Safety Training and Inspection Endorsed. *Engr. and Min. Jnl.* (Nov. 1948) 149 (11) 76–78.
4. J. D. Cooner. The Foundation of Safety Engineering and Planning. TP 2424 *Coal Tech.* (Aug. 1948); *Trans.* AIME (1948) 177, 185.
5. C. F. Davis: Safety Program of the United Mine Workers of America. Paper presented at 62d Annual Meeting of the Coal Mining Inst. of Amer. (Dec. 10, 1948) 6 pp.
6. John H. Hansford: Causes and Prevention of Mine Fires on Conveyor Belts. *Proc.* of the 38th Convention, Mine Inspectors' Inst. of Amer. (1948) 63–68.
7. Paul H. Price and John P. Nolting: Mine Roof-Fall Fatalities. *Min. Cong. Jnl.* (Oct. 1948) 34 (10) 40–41.
8. *Proc.* of the 38th Convention, Mine Inspectors' Inst. of Amer. (June 7–9, 1948) 198 pp.
9. *Proc.* of the 24th Annual Conference, Lake Superior Mines Safety Council. (June 17–18, 1948) 159 pp.
10. Two New Continuous Mining Machines Demonstrated in Public for First Time. United Mine Workers *Jnl.* (Jan. 1, 1949) 60, (1) 5.
11. Joint Report of the International Officers to the Fortieth Consecutive Convention of the United Mine Workers of America. (Oct. 5, 1948) 148–151.
12. John Bartlow Martin: The Blast in Centralia No. 5, A Mine Disaster No One Stopped. *Harpers* (Mar. 1948) 196 (1174) 193–220.
13. Who Killed the Centralia Miners? *Readers Digest* (Apr. 1948) 52, (312) 83.

14. J. H. Auburn: Safety in the Nonferrous Smelting and Refining Industry. Paper read before the Mining Section, 36th National Safety Congress. (Oct. 1948) 16 pp.
15. F. D. Bickel: Blasting Hazards in Metal Mines. *Proc.* National Safety Cong., Min. Sec. (Oct. 18, 1948) 10 pp.
16. E. R. Price: Safety Education. *Min. Cong. Jnl.* (Dec. 1948) 34 (12), 53.
17. C. C. Conway: Roof Support With Suspension Rods. *Proc.* Mine Inspectors' Inst. of America. (June 9, 1948) 80–87.
18. Richard Maize: The Coal Industry's Number One Hazard. *Proc.* of the 38th Convention, Mine Inspectors' Inst. of America. (June 9, 1948) 71 and 72.
19. E. R. Maize: Safety Director, National Coal Association. What Industry Can Do For Safety. Paper presented at 62d Annual Meeting of the Coal Min. Inst. of Amer. (Dec. 10, 1948).
20. Hearings Before a Special Subcommittee of the Committee on Public Lands, U. S. Senate, 80th Congress, first session, S. Res. 98. A Resolution to Investigate the Explosion at Centralia Coal Mine No. 5, WAMAC, Ill., on March 25, 1947, Apr. 3–4–5–10–16–17, 1947, 470 pp.
21. Report No. 238, 80th Congress, first session, Committee on Public Lands, U. S. Senate. Investigation of Mine Explosions at Centralia, Ill. (June 5, 1947) 15 pp.
22. Injuries and Employment in Bituminous-Coal Mines December 1947 and Years 1946–47. Bur. of Mines *H.S.S.* 378, 12 pp.
23. Injuries and Employment in Pennsylvania Anthracite Mines, 1947. Bur. of Mines *H.S.S.* 379 (1948) 4 pp.
24. Forest T. Moyer: Employment and Injuries in the Mineral Industries. Bur. of Mines Minerals Yearbook for 1946. (1948) 74–89.
25. Seventy-Five Years of Progress in the Mineral Industry. AIME, 75th. Anniversary Volume (1947) 194–195, 237, 264–267.
26. Paul M. Tyler: From the Ground Up. 34–41. 1948, McGraw-Hill Book Co., Inc.
27. Joseph J. Walsh: Circular Letter No. 132-A to all Anthracite Mine Inspectors, Mine Officials, and Miners. Commonwealth of Pa., Dept. of Mines. (Jan. 3, 1949) 4 pp.
28. I. N. Bayless: How Union Pacific Coal Has Made a Notable Safety Record. *Min. and Met.*, (Dec. 1948) 29 (12) 657.
29. S. H. Ash: Safety Committees in the Coal Mines of the State of Washington. Bur. of Mines *I. C.* 6283 (June 1930) 9 pp.
30. An act relating to certain inspections and investigations in coal mines for the purpose of obtaining information relating to health and safety conditions, accidents, and occupational diseases therein, and for other purposes. Public Law 49, chapt. 87, H. R. 2082, 77th Congress, first session, May 7, 1941, 4 pp.
31. Federal Mine Safety Code for Bituminous-Coal and Lignite Mines of the United States. Bureau of Mines Handbook (1946) 90 pp.
32. Tentative Inspection Standards for Anthracite Mines. Bur. of Mines *I. C.* 7282 (May 1944) 48 pp.
33. Pp. 87–95 of ref. 8.
34. Industrial Code Relating to Underground Mining Operations. Dept. of Labor, Board of Standards and Appeals, Albany, N. Y. (1948) 41 pp.
35. Handbook of Rules Governing the Operation of Mines. Province of Ontario, Dept. of Mines, Toronto. (1948) 254 pp.
36. First Organization and Work of the Coal-Mine Inspection Division. Bur. of Mines *I. C.* 7243 (June 1943) 138 pp.
37. E. R. Borcherdt: The Role of Research in the Development of Labor-saving Equipment and Methods. *Min. Cong. Jnl.* (1948) 34 (11) 32–35 and (12) 49–52.
38. A New Continuous Mining Machine Announced. *Min. Cong. Jnl.* (Dec. 1948) 34 (12) 36.
39. John J. Curzon: Changing Mining Methods at the Holden Mine. *Trans.* AIME (1945) 163, 73–95.
40. E. J. Eisenach: Safety in Slusher and Scraper Operations Climax Molybdenum Company. Paper read before the Min. Sec., 36th National Safety Congress, Oct. 1948, 10 pp.
41. Andrew Hyslop Jr.: The Prevention of Coal-Mine Haulage Accidents. *Proc.* Mine Inspectors' Inst. of Amer. (1948) 99–104.
42. C. R. Young and others. Investigations Regarding the Safety of Hoisting Equipment and Hoisting Practice in Ontario Mines. Province of Ontario, Department of Mines, Toronto, *Bull.* 138, (1947) 214 pp., and *Bull.* 138, Appendix 2, 73 pp.
43. S. H. Ash: Systematic Timbering Rules at the Washington Coal Mines. Bur. of Mines *I. C.* 6316 (1930) 8 pp.
44. Frank E. Cash and Max S. Petersen: Safe Equipment, Guards, and Practices Lake Superior District, Iron-Ore Mines. Bur. of Mines *I. C.* 7454 (Oct. 1948) 98 pp.
45. Edward Thomas and others: Control of Roof and Prevention of Accidents From Falls of Rock and Coal. Bur. of Mines *I. C.* 7471 (May 1948) 9 pp.
46. R. L. Soderberg: Mining Methods of the Holden Mine, Howe Sound Company, Chelan Division, Holden, Wash. Bur. of Mines *I. C.* 7448 (July 1948) 27 pp.
47. D. C. Helms, C. E. Brown, and O. W. Shimer: Stripping Pitching Beds in Pennsylvania Anthracite Region. *Trans.* AIME (1945) 163, 449–466.
48. Leonard Obert and Wilbur Duvall: Use of Subaudible Noises for the Prediction of Rock Bursts, Part II. Bur. of Mines *R. I.* 3654 (July 1942) 22 pp.
49. D. M. McFarland: Better Fragmentation Claimed for Fast-Delay Caps. *Min. and Met.* (Dec. 1948) 29 (504) 660–662.
50. A. B. Hooker: Permissible Mine Equipment Approved During The Calendar Year 1947. Bur. of Mines *I. C.* 7465 (May 1948) 44 pp.
51. J. J. Rutledge, and Clarence Hall: The Use of Permissible Explosives. Bur. of Mines *Bull.* 10 (1912) 34 pp.
52. Federal Register. (July 20, 1946) 11, (141) 7854; Title 30, Mineral Resources, chapt. 1, Bur. of Mines, Dept. of Interior, subchapt. C, sched. 1F, part 15, par. (b)(5), footnote No. 1.
53. S. H. Ash and L. L. Naus: Use of Diesel Locomotives in Tunnels. Bur. of Mines *I. C.* 7222 (1942) 26 pp.
54. L. B. Berger and R. T. Artz: Performance of a Diesel Mine Locomotive. Bur. of Mines *R. I.* 4287 (May 1948) 15 pp.
55. Einar M. Arentzen: Description of the Eickhoff-Schramlader Longwall Coal-Cutting and Loading Machine. Bur. of Mines *I. C.* 7390 (Dec. 1946) 5 pp.
56. John W. Buch: Design and Operation of the Coal Planer, Ruhr District, Germany. Bur. of Mines *I. C.* 7377 (Oct. 1946) 20 pp.
57. R. T. Artz and O. V. Simpson: Emergency Escapeways From Coal Mines. Bur. of Mines *I. C.* 7478 (Aug. 1948) 11 pp.
58. Ernest W. Johnson and Frank E. Cash; Sinking Large-diameter Drill Holes Lake Superior District Underground Iron Mines. Bur. of Mines *I. C.* 7354 (Feb. 1946) 21 pp.
59. D. H. Platt: Shaft Sinking by Rotary Drilling. Bur. of Mines *I. C.* 7336 (Sept. 1945) 14 pp.
60. E. W. Felegy: Progress in a Practical Method of Voice Communication Through Soil and Strata. *Proc.* Mine Inspectors' Inst. of Amer. (June 9, 1948) 112–118.
61. E. W. Felegy and E. J. Coggeshall: Applicability of Radio to Emergency Mine Communications. Bur. of Mines *R. I.* 4294, 56 pp.
62. H. P. Greenwald, and others: Fifth International Conference of Directors of Mine-Safety Research. Bureau of Mines *Bull.* (1948). To be published.
63. S. H. Ash and E. W. Felegy: Analyses of Complex Mixtures of Gases. Application to Control and Extinguish Fires and to Prevent Explosions in Mines, Tunnels, and Hazardous Industrial Processes. Bur. of Mines *Bull.* 471 (1948) 202 pp.
64. Sara J. Davenport: Bibliography of Bureau of Mines Publications Dealing with Health and Safety in the Mineral and Allied Industries 1910–46. Bur. of Mines *T. P.* 705 (1948) 4–8.
65. H. C. Howarth and others: Tests in the Experimental Coal Mine to Determine Requirements for Preventing Propagation of Coal-Dust Explosions in Rooms. Bur. of Mines *R. I.* 4195, (Feb. 1948) 12 pp.
66. Blake R. Awde: Training Course for Supervisors Covers Wide Variety of Subjects. *Hollinger Miner* (Dec. 1948) 3 (12), 4.
67. Lester F. Bishop: How Anaconda Trains Employees to Work Safely and Efficiently. *Eng. and Min. Jnl.* (Aug. 1948) 149 (8), 91–94.
68. H. J. Gemuenden: Job Training at the Montreal Mining Company Mines. Paper read before the Min. Sec., 36th National Safety Congress, Oct. 1948, 10 pp.
69. D. C. Jones, and others: Vocational Training Papers Read Before the 62d Annual Meeting, Coal Min. Inst. of Amer., Pittsburgh, Pa. Dec. 10, 1948.
70. R. W. Fatzinger: Safety Practices in Dredging and Hydraulic Mining. Bur. of Mines *Bull.* 470 (1948) 76 pp.
71. Eric Johnson: Ambassadors From Labor. *Readers Digest* (Jan. 1949) 89–92.

A New Method of Weighting Core and Cuttings in Diamond Drilling

By JOSIAH ROYCE,* Junior Member AIME

To evaluate chemically the sample of rock obtained by diamond drilling, it has long been recognized that the analyses of the two components of the sample, core and sludge, must be given appropriate influence in computing the average analysis of any unit of depth. The purpose of this investigation is to set forth what means are available for apportioning the effect of core and sludge on the final analysis, what variables affect the problem, and what combination of applied mathematics will closest approximate the truth under each condition as these variables proceed within their limitations.

A drill hole is bored in iron ore exploration principally to test variations in rock composition with depth and is usually directed as nearly normal to the bedding of a horizon to be tested as possible. This practice has a tendency to minimize variation in composition laterally which in any event is not likely to be great. It is obvious that the opportunity for change in analysis of a particular rock is not statistically as great radially in a diamond drill hole where the distance in which such a change may occur is from 0.719 in. (EX bit) to 1.469 in. (NX bit) as there would be longitudinally even in a run as short as 5 ft. Variations in composition of bedded or layered rocks are usually greater normal to the bedding than parallel thereto. Even in massive rocks, like porphyries, variations are functions of distance. Hence, in either case, variations along the hole are of greater effect than across it.

Let us examine Fig 1 briefly to observe a cross section of a unit of depth of a typical diamond drill hole.

If we neglect radial change in chemical composition, which we have seen is small compared to lengthwise variation, we can see that if core recovery was 100 pct, the core and its surrounding area, which would be recovered as cuttings (assuming 100 pct sludge recovery), must analyze the same if the sampling is perfect. This is the foundation of this paper, namely, that if core recovery is complete we may assume that the core constitutes as nearly as possible a perfect sample of the ground drilled.

Now let us pass to the methods of weighting core and sludge in the final analysis and then develop each in turn. One might employ core analyses only, sludge analyses only, or apportion the influence of each by one of several methods. The most common apportionment is by direct proportion to relative theoretical volume occupied by each component in the cylinder hollowed out by the drill, known as the Longyear formula.

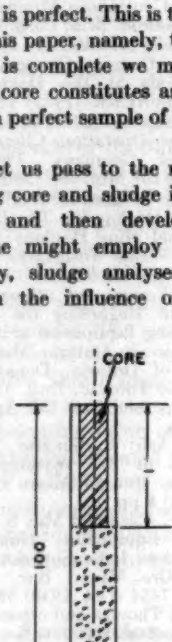


FIG 1—Cross section of diamond drill hole.

San Francisco Meeting, February 1949.

TP 2665 A. Discussion of this paper (2 copies) may be sent to *Transactions* AIME before Nov. 30, 1949. Manuscript received March 7, 1949.

* Geologist, Pickands Mather and Company, Crystal Falls, Mich.

Another logical treatment would be to consider core and sludge in the final analysis according to the weight of each recovered. This procedure was elaborately set forth and refined by R. S. Moehlman.[1] Then to be sure that we have embraced all the possibilities, we must admit that some other method or methods may be devised empirically or by mathematical maneuvers.

Should a drill machine be capable of recovering 100 pct of the core in all types of rock, certainly core alone need be analyzed and no complicated mathematics are required; but although some companies have had fair success in obtaining high percentages of core in certain homogeneous ores on the Marquette Range, their same methods have proved disappointing on the Menominee, Cuyuna, and Gogebic Ranges where the iron formation often varies widely from flinty chert beds interstratified with soft hematite to wholly leached ore material composed of an unpredictable mixture of hematite and limonite with occasional zones of sugary, recrystallized chert. In spite of numerous mechanical improvements in core barrels, few drilling programs can count on complete core recovery.

The sludge alone might be analyzed but for practical reasons this is inadvisable when core is obtained due to the numerous opportunities for contaminating or losing portions of the cuttings.

The Longyear formula involves a weighting of the core and sludge in proportion to the theoretical volume of each, that is, where the volume of the core recovered is one-third of the total cubic volume of the cylindrical hole made by the drill, the analysis of the core is given one-third of the weight in the final analysis. This approach to

[1] R. S. Moehlman: Diamond Drilling in Exploration and Development. *Trans.* AIME (1945) 163, 491–510.

the question has certain disadvantages, particularly in the high core recovery brackets. Even when 100 pct of the core is recovered, the volume of the core is only from 35.5 to 51.2 pct of the volume of the hole, depending on the bit size, and is weighted accordingly. This runs counter to our basic principle that when all the core is recovered it should receive all the weight in the final analysis.

Another often used apportionment is by proportion to the relative weight of core and sludge recovered. This method has proved particularly valuable in the Iron River District when considerable sludge has been lost, and the remainder may be less reliable as a sample of the material ground up. However, the same weakness is found as in the Longyear formula in the regions of high core recovery.

From the above discussion, it seems apparent that some formula must be developed which, while it conforms with volumetric proportions in the lower reaches of core recovery, gradually transfers emphasis to core as recovery mounts. Therefore we are constrained to look into the mathematics of core weighting.

First let us set up the algebraic terms involved:

Let At = the final average analysis of the whole run.

Let A = the analysis of the sludge in the zone which did not core. (This zone is checked in Fig 1.)

Let C = the analysis of the core, as recovered from the zone marked i in Fig 1.

Let S = the analysis of the total sludge both blank and checked areas included. (This is the sludge analysis normally provided by the chemist and is from all or a portion of the whole 100 linear units considered in this analysis as shown in Fig 1.)

Now we are ready to analyze the volumetric or Longyear method of weighting:

Let a = the figure for percentage of the total volume of the hole occupied by core when core recovery is 100 pct. This figure varies between 35.5 and 51.2 and is a function of the relation between the second power of the outside and inside diameters of the particular bit in question.

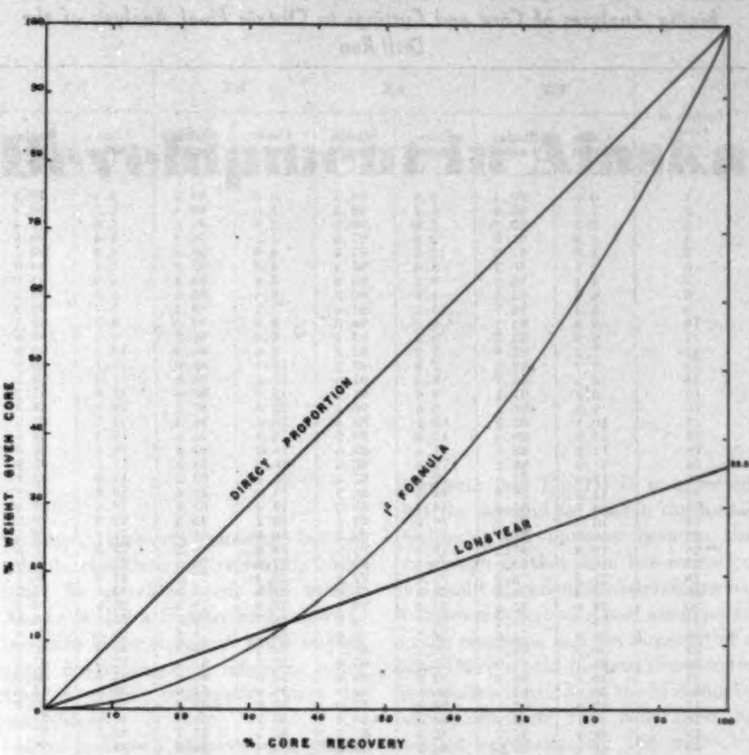


FIG 2—Comparison curves of the direct proportion, i², and Longyear formulas.

Let i = percentage of core recovery.

1. Percentage of total volume in checked area in Fig 1 = $100 - i$

2. Percentage of total volume represented by core = $\frac{ia}{100}$

3. Percentage of total volume in blank area in Fig 1 (sludge which analyzes the same as the core) = $i - \frac{ia}{100}$

4. The percentage of the total volume in the entire sludge = $100 - \frac{ia}{100}$

5. Therefore,

$$S = \frac{\left(i - \frac{ia}{100}\right) C + (100 - i)A}{100 - \frac{ia}{100}}$$

6. Solving for A we find,

$$A = \frac{S\left(100 - \frac{ia}{100}\right) - \left(i - \frac{ia}{100}\right) C}{100 - i}$$

The value of A is quite academic but it does represent the theoretical analysis of the area which did not core.

7. $At = \frac{iC + (100 - i)A}{100}$

8. By substituting the values for A we obtain:

$$At = \frac{S\left(100 - \frac{ia}{100}\right) + \frac{ia}{100} C}{100}$$

This last is the algebraic basis of the Longyear factors, the figures in the table being equal to $\left(100 - \frac{ia}{100}\right)$ or $\frac{ia}{100}$ depending on whether the sludge or the core factor is sought.

Core and sludge influence apportioned according to the weight of each recovered may be expressed mathematically as:

$$At = \frac{SWs + CWc}{Ws + Wc}$$

where Wc and Ws are the weight of core and sludge recovered, respectively. It might be well to note here that this formula cannot be represented graphically since it involves unpredictable variations in core and sludge recovery.

It is suggested that the core and sludge might be weighted directly according to the percentage of each obtained, which would be expressed:

$$At = \frac{S(100 - i) + iC}{100}$$

(See Fig 2 for graphic representation.)

It can be seen that in this direct proportion if core recovery is slight, the core still has a strong influence in the final analysis so that when anomolous beds only are cored, it might prove to give undue weight to the core.

Table 1 . . . Multipliers Derived from the i^2 Formula, to Be Used in Combining Analyses of Core and Cuttings to Obtain Final Analysis of the Drill Run

Inches of Core	EX		AX		BX		NX	
	Core Factor	Sludge Factor	Core Factor	Sludge Factor	Core Factor	Sludge Factor	Core Factor	Sludge Factor
1	0.6	99.4	0.6	99.4	0.8	99.2	0.9	99.1
2	1.2	98.8	1.2	98.8	1.6	98.4	1.7	98.3
3	1.8	98.2	1.8	98.2	2.4	97.6	2.6	97.4
4	2.4	97.6	2.4	97.6	3.2	96.8	3.4	96.6
5	3.0	97.0	3.0	97.0	4.0	96.0	4.3	95.7
6	3.5	96.5	3.6	96.4	4.8	95.2	5.1	94.9
7	4.1	95.9	4.2	95.8	5.6	94.4	6.0	94.0
8	4.7	95.3	4.8	95.2	6.4	93.6	6.8	93.2
9	5.3	94.7	5.4	94.6	7.2	92.8	7.7	92.3
10	5.9	94.1	6.0	94.0	8.0	92.0	8.5	91.5
11	6.5	93.5	6.6	93.4	8.8	91.2	9.4	90.6
12	7.1	92.9	7.2	92.8	9.6	90.4	10.2	89.8
13	7.7	92.3	7.8	92.2	10.4	89.6	11.1	88.9
14	8.3	91.7	8.4	91.6	11.2	88.8	11.9	88.1
15	8.9	91.1	9.0	91.0	12.0	88.0	12.8	87.2
16	9.5	90.5	9.6	90.4	12.8	87.2	13.7	86.3
17	10.1	89.9	10.2	89.8	13.6	86.4	14.5	85.5
18	10.6	89.4	10.8	89.2	14.4	85.6	15.4	84.6
19	11.2	88.8	11.4	88.6	15.2	84.8	16.2	83.8
20	11.8	88.2	12.0	88.0	16.0	84.0	17.1	82.9
21	12.4	87.6	12.6	87.4	16.8	83.2	17.9	82.1
22	13.5	86.5	13.5	86.5	17.6	82.4	18.8	81.2
23	14.7	85.3	14.7	85.3	18.4	81.6	19.6	80.4
24	16.0	84.0	16.0	84.0	19.2	80.8	20.5	79.5
25	17.3	82.7	17.3	82.7	20.0	80.0	21.3	78.7
26	18.8	81.2	18.8	81.2	20.8	79.2	22.2	77.8
27	19.4	80.6	19.4	80.6	21.6	78.4	23.1	76.9
28	21.8	78.2	21.8	78.2	22.4	77.6	23.9	76.1
29	23.4	76.6	23.4	76.6	23.4	76.6	24.8	75.2
30	25.0	75.0	25.0	75.0	25.0	75.0	25.6	74.4
31	26.7	73.3	26.7	73.3	26.7	73.3	26.7	73.3
32	28.4	71.6	28.4	71.6	28.4	71.6	28.4	71.6
33	30.3	69.7	30.3	69.7	30.3	69.7	30.3	69.7
34	32.1	67.9	32.1	67.9	32.1	67.9	32.1	67.9
35	34.0	66.0	34.0	66.0	34.0	66.0	34.0	66.0
36	36.0	64.0	36.0	64.0	36.0	64.0	36.0	64.0
37	38.0	62.0	38.0	62.0	38.0	62.0	38.0	62.0
38	40.1	59.9	40.1	59.9	40.1	59.9	40.1	59.9
39	42.3	57.7	42.3	57.7	42.3	57.7	42.3	57.7
40	44.4	55.6	44.4	55.6	44.4	55.6	44.4	55.6
41	46.7	53.3	46.7	53.3	46.7	53.3	46.7	53.3
42	49.0	51.0	49.0	51.0	49.0	51.0	49.0	51.0
43	51.4	48.6	51.4	48.6	51.4	48.6	51.4	48.6
44	53.8	46.2	53.8	46.2	53.8	46.2	53.8	46.2
45	56.3	43.7	56.3	43.7	56.3	43.7	56.3	43.7
46	58.8	41.2	58.8	41.2	58.8	41.2	58.8	41.2
47	61.4	38.6	61.4	38.6	61.4	38.6	61.4	38.6
48	64.0	36.0	64.0	36.0	64.0	36.0	64.0	36.0
49	66.7	33.3	66.7	33.3	66.7	33.3	66.7	33.0
50	69.4	30.6	69.4	30.6	69.4	30.6	69.4	30.6
51	72.3	27.7	72.3	27.7	72.3	27.7	72.3	27.7
52	75.1	24.9	75.1	24.9	75.1	24.9	75.1	24.9
53	78.0	22.0	78.0	22.0	78.0	22.0	78.0	22.0
54	81.0	19.0	81.0	19.0	81.0	19.0	81.0	19.0
55	84.0	16.0	84.0	16.0	84.0	16.0	84.0	16.0
56	87.1	12.9	87.1	12.9	87.1	12.9	87.1	12.9
57	90.3	9.7	90.3	9.7	90.3	9.7	90.3	9.7
58	93.4	6.6	93.4	6.6	93.4	6.6	93.4	6.6
59	96.7	3.3	96.7	3.3	96.7	3.3	96.7	3.3
60	100.0		100.0		100.0		100.0	

Since the only defect of the Longyear or volumetric formula in the high brackets of recovery is due to the factor "a," an empirical solution might be to substitute "i" for "a" so that as recovery increases the core analysis may be multiplied by a factor greater than from 35.5 to 51.2 pct.

The formula would then become:

$$At = \frac{S\left(100 - \frac{i^2}{100}\right) + \frac{i^2}{100}C}{100}$$

For brevity, we will refer to this as the i^2 formula.

By substituting zero and 100 for i, it can be seen that when core recovery is zero, the core is given no weight and when recovery is 100 pct, the weight given the core conforms with our ideal, so on two points we are immediately satisfied with the formula. There are then two avenues of approach by which we may analyze the validity of the formula; the first is by examining graphs of the different formulas and using common sense; the second is by actual application of the formula to real problems encountered in the field.

In Fig 2, the curves of three of the above formulas have been plotted on a graph whose ordinate is the percentage of weight given the core in the analysis of the whole run, and whose abscissa is the percentage of core recovery. Note that the direct proportion formula gives an exceedingly high rating to core from the outset while the i^2 curve begins its major departure from the Longyear curve in the high regions of core recovery just where we have felt dissatisfied with the volumetric figures.

Some drilling on the Vermillion Range in Minnesota would have given a particularly deceptive answer had the Longyear formula been used blindly. The material drilled was flinty, hard, magnetic, lean, unoxidized iron formation, and while the figures below represent an extreme example, it is felt that they will illustrate the point.

Depth: 590 to 595 ft.
Core recovery: 59 in. or 98.33 pct.
Core analysis: 5.98 pct Fe.
Sludge analysis: 43.72 pct Fe.
Bit size: AX.

The Longyear figures give the following:

$$At = \frac{35.4 \times 5.98 + 64.6 \times 43.72}{100}$$

$At = 30.36$ pct Fe, an analysis which might place this formation in the realm of commercial concentration by metallurgical methods. The i^2 formula gives:

$$At = \frac{96.70 \times 5.98 + 3.30 \times 43.72}{100}$$

$At = 7.23$ pct Fe, an analysis which demonstrates the worthless character of the formation.

While this case is admittedly an extreme one, an examination of many hundreds of feet of this same drilling reveals that although core recovery was mainly higher than 70 pct, the sludge ran consistently from 1½ to 3 times as high in iron as the core. There was probably some metallic iron present, caused by abrasion of the drilling apparatus in the hole by the extremely hard formation. Also concentration of magnetite by agglomeration in the sludge was noted, partly influenced by the grease used on the core barrel.

Numerous holes in active mines are being examined and comparison is being made between corresponding drill runs and mine samples to confirm or deny the validity of the i^2 formula. So far, most of the areas where comparison can be made have happened to be in low core recovery holes and here the Longyear or volumetric figures check very well. However, at no point where high core recovery was attained has the i^2 formula been found seriously in error.

As a result of this research the writer has made up a table which employs both the Longyear and the i^2 formulas. Table 1 employs the Longyear figures up to the point of coincidence of the Longyear and i^2 curves (see Fig 2) and then follows the i^2 curve to 100 pct.

Several thousand feet of drilling on several of the iron ranges in the Lake Superior District in which core and sludge have been weighted according to Table 1 have given apparently satisfactory results, and it is hoped that it may prove useful in other regions.

Coal Mine Development in Alaska

By ALBERT L. TOENGES,* Member AIME

Alaska requires an adequate fuel supply for its development, and has large potential coal reserves ranging from lignite to subbituminous and anthracite.

Coal production in the Territory now is less than the requirements. In 1947, production was 361,000 tons, divided about equally between bituminous coal from the Matanuska field and subbituminous coal from the Nenana field. There is need for development of modern mechanized mines, which should produce the required output with a minimum of workers. These mines should not be thought of in the light of large potential capacity, as in the States. However, these new mines should be developed by modern methods, which should result in lower costs than at present. Because of the diverse physical conditions in the coal fields, intensive investigation by diamond drilling is necessary to properly plan the development and equipment of mine sites at minimum cost. The Bureau of Mines is doing this now in the Wishbone Hill area of the Matanuska field. All coal land in Alaska is government-owned and subject to the Coal Leasing Act.

Coal mining in Alaska has been handicapped by an inadequate supply of dependable workers. Wage scales have been very high in recent years, and "floaters" have been attracted to the coal mines. This type of labor is not conducive to efficient operation. Modernization of mines will require skilled and dependable workers and to induce such men to become interested in coal mining in Alaska, modern facilities, such as modern houses, schools, churches, and recreation halls, must be provided near the mines. Alaska is still a frontier and improvements in living standards must accompany development of mines in order that a stable community may be established.

Coal is known to have been mined in Alaska at Port Graham, on Cook Inlet, by the Russians in 1854. During the Klondike gold rush in 1898, coal was mined in scattered areas for use on steamers plying the Yukon River and its navigable tributaries. After the Alaska Railroad was built, two important fields were developed—the Nenana and the Matanuska (Fig 1). The Bering River field was explored by the Guggenheim interests at one time, and a railroad to the area was constructed. However, the field was abandoned because of litigation and reported unsatisfactory physical condition of the beds.

There are areas that today are unimportant but which may be developed in the future. Possibly the most important of these is the deposits of subbituminous coal adjacent to Cook Inlet, near Homer, on the Kenai Peninsula (see Fig 1). It is expected that the demand for coal in the Kenai Peninsula will increase because the population in that area has increased as a result of agricultural development. Numerous outcrops of coal are exposed on the peninsula and development of a mine there would obviate dependence on supplies of coal from the Matanuska field. Coal from this field must be shipped approximately 160 miles by rail to Seward and transported thence by boat about 180 miles to Homer. There has been no regular boat service from Anchorage to Homer.

There are deposits of coal in the Arctic region but a description of them will not be given in this paper, which will describe the more important deposits in the Alaska Railroad belt. The results of a reconnaissance in the Arctic have been described.[1]

San Francisco Meeting, February 1949.

TP 2686 F. Discussion of this paper (2 copies) may be sent to *Transactions* AIME before Nov. 30, 1949. Manuscript received March 7, 1949.

 Work completed on manuscript Nov. 24, 1948.

* Principal Coal Mining Engineer, Fuels and Explosives Division, U. S. Bureau of Mines, Pittsburgh, Pa.

Description of Fields

MATANUSKA FIELD

The Matanuska field lies in the valleys of the Matanuska River and its tributaries and their separating ridges. This field has been interpreted by geologists as a sunken fault block that separated the Talkeetna Range of mountains from the Chugach Range.

The Matanuska River flows west along the south side of the field and the Glenn highway, which extends from Anchorage via Palmer to the Richardson highway near Glen Allan, follows the Matanuska Valley. This road to the coal field can be traveled the year around. Although the snow-

[1] Albert L. Toenges and Theodore R. Jolley: Investigation of Coal Deposits for Local Use in the Arctic Regions of Alaska and Proposed Mine Development. U. S. Bur. Mines *R. I.* 4150 (1947) 19 pp.

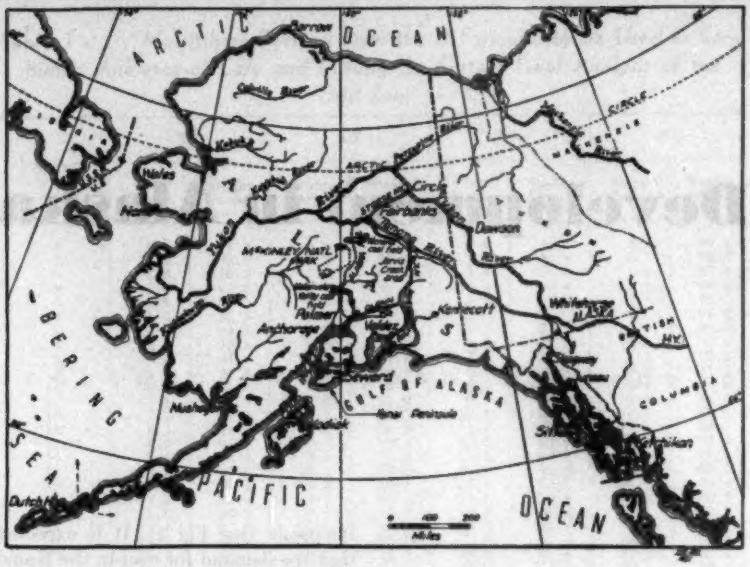


FIG 1—Map of Alaska showing coal fields. (*Map courtesy U.S. Bureau of Mines.*)

fall may be 36 in., the road is kept passable.

The coal exposures occur in an area approximately 25 miles long by 7 miles wide and parallel the general trend of the Matanuska Valley. Complexity of geologic structure exists in the area and there are igneous intrusions which appear to increase progressively from west to east. These features have, no doubt, influenced the rank of the coal. This is true of the high quality of the coal found at Chickaloon on the eastern end of the area.

The coal beds, which are predominantly bituminous in rank, occur in the Chickaloon formation of Tertiary age. This formation, which is below the Eska conglomerate, comprises claystone, siltstone, sandstone, a few thin beds of fine-grained conglomerates, and coal beds. These coal beds generally occur in the upper 1400 ft of the formation. Lateral changes in the thickness of the coal beds and quality of the coal results in various coal beds being minable in one location and not in another.

Evan Jones Mine

At present, the Evan Jones mine, the only mine in operation in the Matanuska coal field (see Fig 2), at Jonesville, is on the Matanuska branch line of the Alaska Railroad about 17 miles east of Palmer by highway and 58 miles from Anchorage via Palmer. The coal ships and stores well and is preferred to the subbituminous of the Nenana field to the north. The life of this mine is limited owing to physical conditions. Most of the present production is from pillars.

The main opening of the Evan Jones mine is a single drift driven at water level. This drift passes through 300 ft of glacial gravel and approximately 400 ft of rock and then penetrates the south limb of the coal-bearing formations of the syncline, which extends for about 800 ft. Six coal beds, with dip ranging from 11 to 30° north, were found in this limb of the syncline. The main drift then extends approximately 800 ft north in rock to the coal formations in the north limb of the syncline. Ten coal beds were found in this limb, and dips range from 25 to 35° to the south.

The minable coal has been extracted from the beds in the south limb of the syncline east of the Jonesville fault, which crosses the main drift about 1400 ft north of the mine workings in this limb of the syncline.

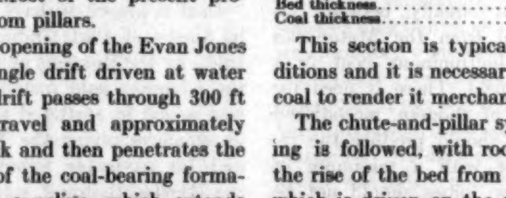
Current production is from the No. 3 bed in the north limb of the syncline. The thickness ranges from 8 to 12 ft. A section of this bed at 8 chute main gangway, 18 crosscut, is as follows:

Description	Thickness Ft	In.
Roof—claystone	2	
Roof coal	0	5
Hard claystone	0	1
Coal	1	5
Hard claystone	0	½
Coal	1	4
Fine sandstone parting	0	½
Coal	1	1
Siltstone, thin coal stringers	0	2
Coal	0	5
Siltstone, occasional coal stringers	0	8
Coal	2	5
Hard claystone lense	0	½
Coal	0	5
Claystone lense	0	½
Coal	0	7
Bottom coaly claystone (upper contact breaks well)	1	
Bed thickness	8	1
Coal thickness	7	1

This section is typical of bed conditions and it is necessary to wash the coal to render it merchantable.

The chute-and-pillar system of mining is followed, with rooms driven up the rise of the bed from the gangway, which is driven on the strike. Rooms are turned on 50-ft centers and driven

2



3

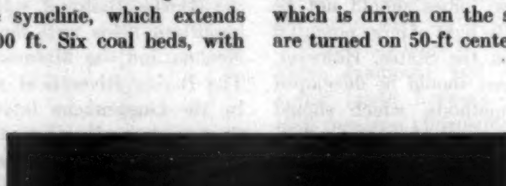


FIG 2—Surface plant of Evan Jones mine.
FIG 3—Tipple and working Eska mine.
(*Photographs courtesy U.S. Bureau of Mines.*)

10 ft wide and about 5 ft high for a distance of about 1100 ft. A block comprises five rooms. Crosscuts between rooms are on 50-ft centers. After the room has been driven to its limit, the upper 3 to 7 ft of the bed and pillars are removed on retreat. Pillars are extracted by taking successive angle slabs off them. The coal flows by gravity to a chute on the haulageway.

The production of the mine, which averages about 450 tons per day is prepared in a surface plant. The plus 3-in. coal is hand-picked, and the minus 3-in. is washed in a jig-type washer.

Electric power for underground and surface operations is generated at the mine by a 300 kw, 440 v, 3-phase, alternating-current, steam turbine-generator.

Eska Mine

This mine (Fig 3) was operated by the Alaska Railroad but was abandoned in June 1946 owing to adverse physical and labor conditions. The mine was well-equipped with a preparation plant containing a Baum-type jig.

Moose Creek District

The Moose Creek district (Fig 4) lies on the north limb of the Wishbone Hill syncline in the western part of the Matanuska field, about 5 miles west of Jonesville. At one time a

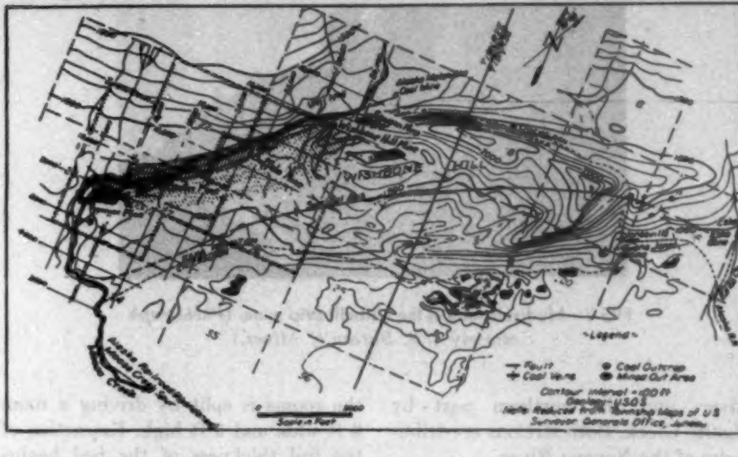
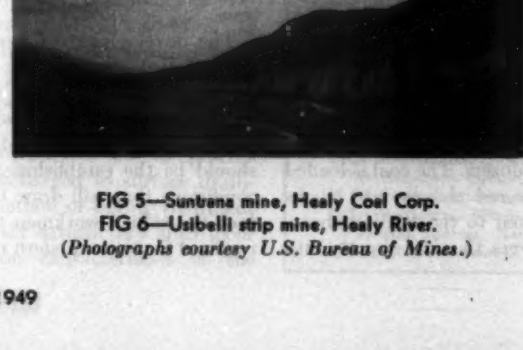


FIG 4—Map of Moose Creek District. (*Map courtesy U.S. Bureau of Mines.*)

branch line of the Alaska Railroad extended 4 miles up Moose Creek to near the Premier mine. This line was abandoned after a heavy flood in 1942. The district is accessible over a 6-mile all-weather road that extends from the Glenn highway.

Coal mining first began in the Moose Creek district in 1916 and continued intermittently until after the war. The Pioneer, Baxter, Rawson, Alaska Matanuska, and Premier mines have been abandoned. Physical conditions in and surrounding the beds were the principal factors leading to their abandonment. Some areas have been disturbed by intense faulting and folding, and correlation of beds and extent are difficult to interpret from drill-hole logs.

5



6

FIG 5—Suntrana mine, Healy Coal Corp.
FIG 6—Usibelli strip mine, Healy River.
(*Photographs courtesy U.S. Bureau of Mines.*)

Buffalo Mine

This mine, which ceased operation at the close of World War II, is in Moose Creek district, 6 miles by road from the Glenn highway and 12 miles from Palmer. Coal was hauled by truck 7 miles to Moose Creek siding for shipment on the Alaska Railroad to Anchorage or directly by truck to Palmer.

The mine was developed from a water-level drift that intercepted the Nos. 2, 3, 4, and 5 beds of the Buffalo group and a slope sunk on the No. 2 bed. Mining has been conducted in the Nos. 2, 3, and 4 beds, and the main gangway has been driven in the No. 5 bed. The average thickness of the beds in the drift is: No. 2 bed, 6 ft 6 in.; No. 3 bed, 2 ft 9 in.; No. 4 bed, 2 ft 9 in.; No. 5 bed, 8 ft, with a number of shale and bone partings. The thickness of these beds varies throughout the mine, and the variations occur in a distance of about 35 ft. The dip of the beds is 65° southeast near the surface, and there appears to be a decrease in dip with depth as the basin of the syncline is approached. The interval between beds may make the mining of some beds difficult. The coals are high-volatile B bituminous and noncoking.

NENANA FIELD

This field is in the northern foothills of the Alaska Range, adjacent to the Nenana River and the Alaska Railroad. It is approximately 100 miles southwest of Fairbanks. The southern part of the area is drained by the Healy

FIG 7—Hydraulicking at the Usibelli strip mine. (*Photograph courtesy U.S. Bureau of Mines.*)

River, and the northern part by Lignite Creek. Both streams are tributaries of the Nenana River.

Beds of low-rank subbituminous coal and lignite occur in the area, which is characterized by the absence of extreme structural disturbances and igneous intrusions. The thickness of the beds ranges from 6 to 50 ft and dip from 10 to 70°.

Coal has been produced from one underground mine, Suntrana, of the Healy River Coal Corp.; and the Usibelli and the Diamond strip mines.

The coal beds are exposed along the banks of Healy Creek for about 12 miles. Both banks of the stream are formed by outcrops, which are 20 to 50 ft above the bottom of the stream. The No. 1 bed is the north bank of Healy Creek for 4 miles east of Suntrana.

Suntrana Mine

The Suntrana mine (Fig 5) is on the north bank of Healy Creek. A branch line of the Alaska Railroad extends to the mine from Healy, which is approximately 112 miles south of Fairbanks and 244 miles north of Anchorage.

The main opening is a drift driven through rock at water level. This drift intersects the various coal beds that outcrop on the surface and dip approximately 18 to 28° north. The beds are numbered in ascending order from 1 to 6, and below 1 in descending order from F to A. Thickness of the beds ranges from 12 to 50 ft.

The chute-and-pillar system of mining is employed. Gangways and counters are driven on the strike of the beds, and rooms are turned on 50-ft centers and driven 8 ft wide and 8 ft high up the rise of the bed for about 200 ft. Crosscuts between rooms are on 50-ft centers. After two rooms have been developed, the pillar between the rooms is split by driving a room 8 ft wide and 8 ft high. Extraction of the full thickness of the bed begins at the top of the room by taking successive cuts from the pillar at about 45° and mining the top coal in the rooms. Batteries constructed of timber are built across the room at about 35 ft intervals. Coal is drawn into chutes from the battery until a high percentage of cave rock appears. Broken coal is drawn from rooms at a rate that will provide height for men mining the roof coal. About 2 ft of roof coal is left to support the overlying sand during mining. This top coal falls later. All coal is shot off the solid.

Coal passes by gravity in steel-lined chutes to cars on the entry. Loaded trips are transported to the tipple by electric-battery locomotives. Coal is hand-picked and screened to produce 6-in. lump, nut, and slack. The principal consuming area is Fairbanks and vicinity.

The coal is subject to spontaneous combustion, and a number of underground fires have occured which have been sealed with sand barriers.

Usibelli Strip Mine

The Usibelli strip mine is on the north bank of Healy Creek, about 2½ miles east of the Suntrana mine (Fig 6 and 7).

Production comes from the No. 1 bed, which is 35 to 40 ft thick. The strike of the bed is east-west paralleling Healy Creek. The dip ranges from 20 to 30° north. The coal bed outcrops above water level in the north bank of Healy Creek and is mined down-dip to water level. Overburden, which is an arkose, is moved by hydraulicking and with bulldozers. The coal is loaded by diesel-powered shovels into trucks and transported to the loading chute, which discharges the coal directly into railroad cars at the railroad siding adjacent to the Suntrana mine.

Diamond Strip Mine

The Diamond strip mine is about 5 miles southwest of Healy. A truck road has been constructed from the railroad siding, 1 mile north of Healy, to the mine. The road traverses glacial morains and is subject to temporary closure by drifting snows in winter.

Production comes from a 40-ft bed of coal that strikes S 62°W and dips 33° northwest with the slope of the hill. The overburden is moved with a diesel-powered shovel and bulldozer. The coal is loaded into trucks with a diesel-powered coal-loading shovel.

Future development as a strip mine is limited by the increasing thickness of the overburden and inadequate equipment.

There are other scattered coal areas near the Alaska Railroad, such as deposits near the north boundary of McKinley National Park, Broad Pass, and Colorado, but the areas that have been described present opportunities for development near rail transportation.

Summary and Conclusions

Anchorage is the largest town in Alaska, and, with Army installations, an increase in the supply of bituminous coal, which stores well, is needed. The physical conditions in the Matanuska field are such that before an investment in the development of modern mechanized mines is made, a thorough study of the area and investigation by diamond drilling is necessary. The Bureau of Mines is beginning an investigation by diamond drilling of an area in Wishbone Hill southwest of Jonesville. A study of the area by geologists of the Geological Survey indicate a large potential reserve of coal and no adverse physical conditions, such as faults of large magnitude. The objective of the Bureau's investigation is to determine minable reserves for mine sites in this area.

The development of modern mines of sufficient capacity to fulfill the requirements of Alaska should be given consideration by coal operators, but included in this development should be the establishment of living conditions that will draw to the territory the skilled workmen that will be required for these modern mines.

Electrical Dewatering of Phosphate Tailing

By E. C. HOUSTON,* Member AIME, V. J. JONES,* and R. L. POWELL†

The phosphate ores mined in middle Tennessee typically consist of granular rock phosphate particles disseminated in a clayey matrix. In the TVA plant near Columbia, Tenn., the phosphate ore is mined, made into a slurry with the addition of a small amount of sodium hydroxide as dispersant, and treated in a hydroseparator to remove minus 10 micron material. The hydroseparator underflow, comprising a rough concentrate, is transported by pipeline to the plant; the hydroseparator overflow, comprising a tailing, is flocculated by addition of calcium sulphate and is discharged to settling ponds at a rate of about 1400 gpm. Sedimentation in the ponds produces a clarified effluent, which may be recycled for use as process water or discharged to surface drainage. This method of tailing treatment is not entirely satisfactory since poor sedimentation characteristics of the tailing result in poor ultimate utilization of pond storage volume. The sediment contains about 70 pct water, even after several years of settling, and is not sufficiently dry to permit it to be used as back-fill, which would provide a method for reclaiming ponds that had been filled with sediment.

Since important advantages would result from a process whereby the water content of the tailing solids would be made substantially lower than that obtained in the present process, several possibilities of achieving this were considered. Flocculation tests were made with a wide variety of chemicals, but none gave any improvement over the results obtained with calcium sulphate. Filtering or centrifuging was found to be infeasible. Small-scale tests of dewatering by electrophoresis showed promising results, so this method was studied further in pilot-plant equipment. It was found that the tailing could be dewatered by electrophoresis to produce the solids in a form suitable for use as back-fill. However, the dewatered tailing has no monetary value at present, and the process is not economically competitive with settling pond operation under present conditions.

This paper describes the pilot-plant work on electrical dewatering. It is believed that the data may find application in dewatering physically similar but economically valuable materials such as clays or mill slimes, or in dewatering phosphate tailing in the event of increased settling pond costs

New York Meeting, February 1948. TP 2630 H. Discussion of this paper (2 copies) may be sent to *Transactions* AIME before Nov. 30, 1949. Manuscript received Dec. 1, 1947.

* Development Section, Division of Chemical Engineering, Tennessee Valley Authority, Wilson Dam, Ala.

† Present address, National Lead Company, South Amboy, N. J.

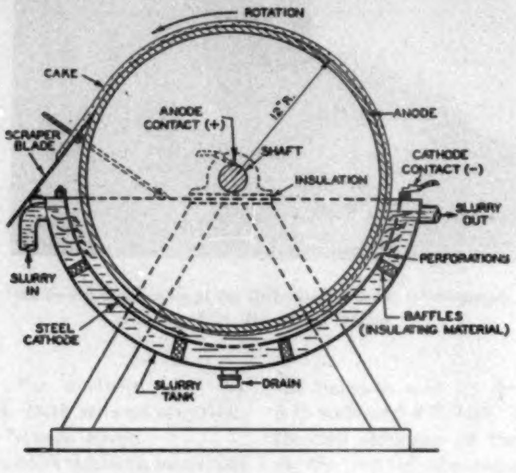


FIG 1—Experimental machine for electrical dewatering of tailing: cross section through center.

or the development of end uses for the tailing solids.

Initial Considerations

Electrophoresis may be defined as the migration of particles in liquid suspension resulting from the application of direct current electricity to the suspension.[1,7] This phenomenon has been found to be applicable to the separation of particles from suspension by deposition on an electrode immersed in the suspension. Although the principles of electrophoresis have been the subject of numerous laboratory investigations,[1,4,7] there have been few commercial applications of the phenomenon to the separation of solids from liquids. This, according to Creighton,[3] is probably due in part to lack of knowledge of conditions necessary for best results. It is also due to the availability of simpler and better-known methods that will usually accomplish solids separation at lower cost, namely, settling, filtering, or centrifuging.

In work on the electrical dewatering[*] of clays, Speil and Thompson[7] found the following conditions to give the best results: high solids concentration in slurry, low conductivity of slurry, high temperature, close spacing of electrodes, and effective mechanical circulation to bring the suspended particles close to the anode. The kind and dosage of dispersant chemical were shown to have important effects that depended on the particular clay being treated. In the present study, an effort was made to fix these variables as near to expected optima as possible prior to starting experimental work. Since, at the TVA plant, it would be feasible to operate with a hydroseparator overflow (dewatering machine feed) containing from 12 to 14 pct solids, 12.5 pct was selected for use in the experimental work. Calculations showed that if the plant were operated with this solids concentration in the hydroseparator overflow it would be necessary that the dewatering machine remove about 35 pct of the solids from the slurry in order that the required rate of solids disposal be achieved. The dewatering machine effluent would contain about 8 pct solids and would be recycled to the mine for use in slurrying fresh ore. Conductivity of the slurry would be governed by suspensoid concentration (fixed as in the foregoing), on kind and dosage of dispersant chemical, and on naturally occurring electrolytes in the process water which is taken from the Duck River. In view of the relatively large volumes of slurry to be handled and the lack of a low-cost source of heat at the plant, preheating of the slurry prior to electrophoresis was considered impractical.

Those variables that would not be controllable in plant-scale operations, such as temperature and natural impurities in the process water, were adjusted in the experimental work to simulate average plant conditions. The investigation included study of the effects of deposition time, type of dispersant chemical, current density, and slurry concentration; the possibility of selective size separation was investigated, and tests were made of several anode materials.

Electrical Dewatering Tests

EQUIPMENT AND MATERIALS

Equipment design, materials, and procedures used in the experimental work were selected with a view to applicability to plant-scale operations. Of the several types of electrophoresis machines proposed in the literature,[4] two appeared to be promising for this specific application. These were (1) the rotating drum type and (2) the continuous-belt type. The rotating drum machine is similar in appearance to a rotary vacuum filter except that the drum has a solid conducting surface that serves as the anode; the solids adhere to this drum and are scraped off with a fixed blade. The continuous-belt type machine has for an anode either an endless metallic strip partly immersed in the slurry or a stationary metal plate over which is drawn an endless cloth strip. The first type has been used for commercial dewatering of kaolin;[4] there are no reported commercial applications of the second. In the present work, small-scale preliminary tests were made in a machine of the continuous cloth belt type in which a 6 in. wide canvas strip was drawn across the inclined steel bottom of a shallow rectangular tank, which contained the tailing slurry. The bottom of the tank served as the anode. The cathode consisted of a flat steel plate, which was suspended ½ in. above and parallel to the anode. It was found that deposition of solids occurred both on the surface of the belt and between the belt and the anode, which made this type of machine unsuitable. Therefore, it was decided that the rotary drum type of machine was the more promising for the intended use.

An experimental electrophoresis machine for the dewatering tests was constructed based on Schwerin's idea;[3] a cross-sectional sketch of the machine is shown in Fig 1. The principal parts were: a semicylindrical tank to hold the slurry, a semicylindrical sheet-steel cathode suspended in the tank, and, concentric with this, a revolving drum of electrically conductive material that dipped into the liquid and served

[1] References are at the end of the paper.
[*] The term "electrical dewatering" as used in this paper denotes electrophoretic separation of solids from aqueous suspension.

as the anode. A fixed scraper blade was provided to remove deposited solids from the surface of the rotating drum; this was set so that it would just clear the drum surfaces without effecting metal-to-metal contact. The machine differed from Schwerin's design principally with regard to the path of slurry travel; instead of feeding into the bottom of a relatively deep slurry tank provided with agitators and directing the flow upward through perforations in the cathode, the flow was directed substantially parallel to the surface of the anode in the electrode region. This reduced the dead space to only about 2 in. between the cathode and the tank; baffles were provided to prevent short-circuiting of the slurry through this region. Both the anode and the cathode were electrically insulated from the slurry tank by means of fiber sheets and strips, and the ends of the drum were painted with insulating varnish to prevent deposition on those areas. The slurry feed and discharge lines were provided with sections of Saran to reduce current leakage through the piping. The anode was 2 ft in diameter by 2 ft long. In most of the tests the anode consisted of a section cut from gray cast-iron pipe and closed by circular steel plates at the ends; some tests, however, were made in which the anode was material other than cast iron, as will be discussed later. The anode was given a rough-machined surface prior to installation. It was rotated by means of a chain-and-sprocket drive from a variable speed reducer, which was driven by a ½ hp motor. The electrode spacing was ⅜ in. in most of the tests although a ⅝-in. spacing also was used. Although a spacing smaller than ⅜ in. could have been used, this was thought to be about the minimum feasible for use in a larger, plant-scale machine without encountering mechanical difficulties. The depth of immersion of the anode cylinder was about 9 in., and the submerged area was about 5.7 sq ft; this area was used in calculating anodic current densities and deposition rates. Electric power was supplied from an 8 kw, dc motor generator, with contact to the anode by means of a brush; power was varied by means of a resistor and was measured with an ammeter and voltmeter. The voltage range was 0 to 100. A view of the machine in operation is shown in Fig 2.

FIG 2—Laboratory machine for electrical dewatering of phosphate tailing.

Since the experimental work was not carried out at the Columbia, Tenn., plant, but at the Wilson Dam, Ala., laboratory of TVA, it was not convenient to use tailing slurry as produced in the hydroseparator. Test slurries for experimental work were prepared in the laboratory from tailing sediment dug from a settling pond at the plant and shipped in moist condition to Wilson Dam. Although the composition of the tailing varied somewhat, the following analysis represents a typical sample in per cent by weight on dry basis: P_2O_5, 9.0; CaO, 10.0; SiO_2, 37.4; Fe_2O_3, 7.9; Al_2O_3, 18.2; loss on ignition, 11.5. All of the particles were smaller than 10 microns and more than 70 pct were smaller than 2 microns. The finer fraction exhibited typical colloidal characteristics, namely, high base exchange capacity and high degree of hydration. In preparing slurries for test purposes the solids were dispersed mechanically in tap water in a tank by means of propeller mixers, and the slurry was adjusted to the desired concentration and dispersant dosage. The laboratory tap water was similar in total solids content to the plant process water. Test slurries were pumped to a constant-head tank that fed the dewatering machine at controllable rates up to 5 gpm. The capacity of the slurry preparation equipment was about 1000 gal, which was sufficient for several hours of continuous operation.

EFFECT OF DEPOSITION TIME

In the electrical dewatering of clays, Speil and Thompson[7] found that the optimum deposition time was that which allowed sufficient dewatering of the deposit without increasing the resistance of the deposit to such a point that the energy consumption per unit of clay increased noticeably. The optimum deposition time varied with different clays. In the present study a series of tests were run in the experimental dewatering machine to determine the effect of deposition time. For these tests, an electrode spacing of ⅝ in. was used so that deposition time, hence cake thickness, could be varied over a wider range than would be permitted by the ⅜ in. spacing that was considered to be the minimum practical for large-scale use. Although the wider spacing caused high power consumptions, the tests served to indicate the relative effects of deposition time on power consumption and on other process variables. The current density was held at 9 amperes per square foot; feed slurry concentration was 12.5 pct; the duration of each test was 30 min; and sodium hydroxide was used as the dispersant at a dosage of about 4 lb per ton of solids, which is the dosage generally used in the plant. The deposition time was varied over the range 0.5 to 6.0 min by varying the speed of rotation of the drum from 4.2 to 60 rph.

The cake thicknesses obtained varied from about ⅛ to ½ in., and the moisture in the cakes was 52 to 58 pct. Results of the tests (Fig 3) indicated that increases in the deposition time served to decrease the power requirement and the deposition rate by only small and approximately equivalent percentages. It was necessary to decrease the voltage with increase in deposition time to maintain a constant current input; this indicated that the deposited material was more conductive than the slurry. It was concluded, therefore, that, in the range of deposition time studied, resistance of

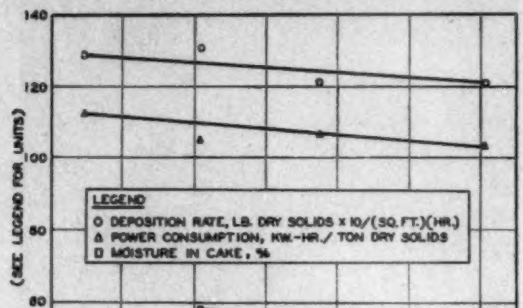


FIG 3—Effect of deposition time in electrical dewatering of phosphate tailing.

Constants: feed concentration, 12.5 pct; dispersant, NaOH (approximately 4 lb per ton solids); solids removed, 43.5 pct of feed solids; current density, 9.0 amp per sq ft; electrode spacing, ⅜ in.

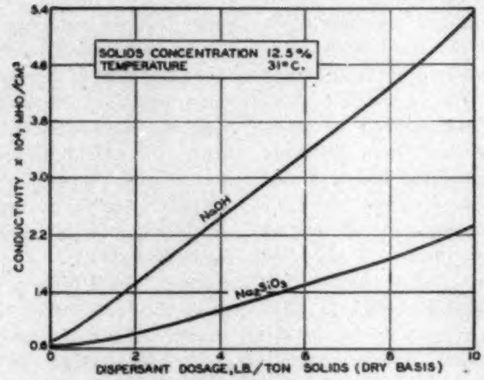


FIG 4—Effects of NaOH and Na_2SiO_3 dispersants on conductivity of tailing slurry.

the cake would not be a limiting factor in machine design and operation. The deposition time should be adjusted to suit the electrode spacing; close spacing would require shorter deposition time. The optimum deposition time would be that which would result in a cake of maximum thickness consistent with providing adequate clearance for the flow of slurry between the cake and the cathode. The optimum electrode spacing would be the minimum consistent with provisions for a reasonable cake thickness and for flow of slurry between the electrodes; as previously stated, the minimum practical spacing was believed to be about ⅜ in. A decrease in power requirement with increase in deposition time was observed up to and including 6 min, which was the maximum used in these tests. Speil and Thompson[7] found, however, that an increase occurred after 10 to 12 min, so it is probable that in the present work an increase would have occurred with longer deposition times. It is believed that the relative effects of cake thickness would be substantially the same with sodium metasilicate, which, in later tests, was found preferable to sodium hydroxide as a dispersant.

EFFECT OF DISPERSANT CHEMICAL

With regard to the best kind and amount of dispersant chemical, preliminary tests showed that sodium hydroxide in a dosage of about 4 lb per ton of tailing solids or, as an alternative, sodium metasilicate at 5.2 lb per ton would be equally suitable from the standpoint of obtaining satisfactory dispersion of the phosphate pulp. Laboratory tests with several other chemicals showed that, although satisfactory dispersion could be obtained with some, the costs for the required dosages would be considerably greater than those for sodium hydroxide or sodium metasilicate. The study of effect of dispersant on electrical dewatering was confined, therefore, to a consideration of these two chemicals, and conductometric titrations were made to determine their relative effects on slurry conductivity since electrophoretic efficiency in dispersed slurries was known to be inversely proportional to conductivity.[1] The slurry samples used were prepared by mechanically dispersing tailing solids in distilled water, and the solids concentrations were adjusted to 12.5 pct by dilution. Sodium hydroxide or sodium metasilicate in the form of 2.5 pct solutions of reagent-grade chemicals was added to the slurry in increments from a burette, and conductivities were measured 20 min after each addition by an alternating current comparison bridge using a dip cell with black platinized electrodes. The reagent dosages were carried somewhat beyond the amounts required for adequate dispersion to determine the effects of overdosage. The results of the titrations (Fig 4) showed that dispersion with sodium metasilicate increased the conductivity considerably less than did dispersion with sodium hydroxide, and it was concluded that sodium metasilicate would be the more desirable dispersant for use with electrical dewatering. It was also concluded (Fig 4) that overdosage of either dispersant would increase the power consumption, although this effect should be less pronounced in the case of sodium metasilicate.

EFFECT OF CURRENT DENSITY

A series of tests were run in the dewatering machine to determine the effects of anodic current density. Since increase in current density would be expected to increase the deposition rate, the feed rates were increased with increase in current density in an attempt to cause a constant percentage of the solids to be removed from the slurry throughout the series and thereby maintain the same average solids concentration in the slurry in the machine. If the feed rates were not adjusted in this way, the power requirement at high current densities would be too high since the more rapid deple-

tion of the solids concentration of the slurry would result in a lower average solids concentration in the machine.

The tests showed (Fig 5) that with an increase in anodic current density within the range 3.7 to 16 amp per sq ft the power requirement increased from 35 to 125 kw-hr per ton of solids removed and the deposition rate increased from 4.5 to 16 lb of solids per square foot per hour; both effects were apparently linear throughout the range investigated. With an increase in current density, the moisture content of the dewatered solids decreased progressively from 62 pct at 3.7 amp per sq ft to 50 pct at 16 amp per sq ft. Because of inability to adjust the feed rate with sufficient accuracy to give a constant percentage removal of solids for all current densities, the average removal was about 40 pct instead of the 35 pct sought. Deviations in percentage removal of solids was believed to be largely responsible for the scattering of data in Fig 5. Although the tests were made with an electrode spacing of ⅜ in., the correlation of deposition rate and cake moisture with current density should be directly applicable to other electrode spacings. The power requirement, however, would increase with increase in electrode spacing.

Selection of current density depends on an economic balance between the cost of power and the equipment cost for a particular dewatering operation. With high current density the power requirement would be relatively high, but the required anode area and hence the equipment requirement would be relatively small. An estimate prepared for the TVA plant showed that a current density of about 7.4 amp per sq ft should be close to the value most economical for that particular installation; it is evident that the value would be different for a different set of conditions.

EFFECT OF CONCENTRATION OF SLURRY

Although Speil and Thompson[7] had demonstrated the beneficial effects of using a high concentration of solids in electrical dewatering of clays, it was desired to obtain quantitative data on this effect with phosphate tailing. A series of three tests were run in the dewatering machine to determine the effect of concentration of slurry. The feed rate was adjusted in each test to supply solids to the machine at the same rate although the volume rates increased with decrease in concentration. The effect of slurry concentration within the range 7.5 to 12.0 pct solids is shown in Table 1.

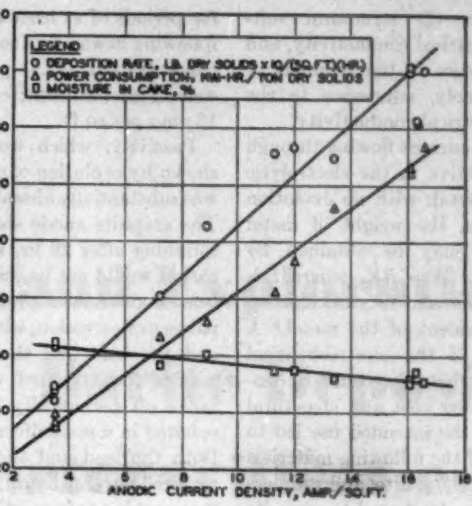


FIG 5—Effect of current density in electrical dewatering of phosphate tailing.

Constants: feed concentration, 12.5 pct; dispersant, Na_2SiO_3 (approximately 5.2 lb per ton solids); solids removed, 40 pct of feed solids; electrode spacing, ⅜ in.

Table 1 . . . Effect of Slurry Concentration

Feed Slurry Concentration, Per Cent Solids by Weight	Power Required, Kw-hr per Ton Dry Solids Deposited	Deposition Rate, Lb Dry Solids per Sq Ft per Hr
12.0	82	12.7
8.7	126	9.2
7.5	157	7.9

The data in Table 1 served to emphasize the importance of a high solids concentration in the feed slurry and confirmed the selection of as high a concentration as was commensurate with efficient phosphate plant operation.

SIZE DISTRIBUTION OF PRODUCTS

The applicability of electrical dewatering would be dependent on recycling all of the depleted effluent from the dewatering machine to the slurrying operation, since the effluent would contain too high a concentration of solids to permit it to be discharged to surface drainage. Therefore, it was important to determine whether a selective particle-size separation occurred, since such action would result in an accumulation of fine or coarse particles that might make the process inoperative. Five sets of samples of feed, cake, and effluent from laboratory dewatering tests were analyzed for particle-size distribution by the pipette method.[8] The results, which are summarized in Table 2, indicated that size segregation, if any occurred, would be too small to cause adverse effects. It is probable, however, that tailing containing solids much larger than 10 microns would require a removal of coarse particles prior to electrical dewatering, since the process is theoretically not applicable to coarse materials.

Table 2 . . . Particle-size Distribution in Feed and in Products of Electrical Dewatering[a]

Material	Per Cent of Total Solids, Dry Basis		
	+10 Micron	−10 + 2 Micron	−2 Micron
Feed	1.2	19.9	78.9
Cake	1.6	19.7	78.7
Effluent	0.4	21.6	78.0

[a] Average of determinations made on five sets of samples.

TESTS OF VARIOUS ANODE MATERIALS

Characteristics of the tailing slurry were such that chemical corrosion of equipment would not be expected to constitute a major problem; however, electrolytic corrosion of the anodes would be expected to be appreciable and therefore would require consideration in selecting an anode material. Since contamination of the tailing with corrosion products would not be detrimental, the principal factors in the selection of the most suitable anode material would be: (1) cost versus

corrosion rate, (2) structural suitability and electrical conductivity, and (3) characteristics of the products of corrosion, namely, adherence to the anode and electrical conductivity.

If all of the current flowing through an anode is active in the electrolytic corrosion of metal, with no evolution of free oxygen, the weight of metal corroded, W, may be obtained by Faraday's law: $W = itK$, where i is current, t is time, and K is the electrochemical equivalent of the metal.[5] A consideration of the electrochemical equivalents of the more common conductors and their cost and structural suitability for the intended use led to the selection of the following materials for testing: iron, graphite, and stainless steel. Lead was also tested because its use has been reported in commercial electrical dewatering of kaolin.[4] The use of one of the "electrically conductive" rubber compounds as an anode coating was considered but was rejected as unpromising because of the relatively high resistivity of commercially available materials of this class. The usual methods for making chemical corrosion rate tests on small specimens were not applicable to the testing of electrophoretic corrosion, principally because of lack of a convenient method for the continuous removal of the deposited solids from the specimens while maintaining relatively constant conductivity, solids concentration, and dispersant dosage in the slurry. The only test procedures that appeared feasible were: (1) the use of a small-scale model of the laboratory machine or (2) the use of the laboratory machine as a corrosion test unit. The first method would have the advantage of using anodes small enough to weigh with sufficient accuracy to estimate corrosion by weight loss, although it would have the disadvantage of requiring the construction of a replica of equipment already on hand and would probably present difficulties in control of operation. It was decided that neither method would be likely to give dependable quantitative data on the subject but that tests made with the laboratory machine should provide qualitative information sufficient for determining the relative suitability of the four materials under consideration. Anodes to fit the laboratory machine were made from furnace-electrode graphite, gray cast-iron pipe, chemical lead sheet, and Type 430 stainless steel sheet, respectively. Each of the anodes was tested by operation in the machine for periods of at least 20 hr under the following dewatering conditions: slurry concentration, 12.5 pct; dispersant, sodium metasilicate; current density, 12 amp per sq ft.

Passivity, which would have been shown by evolution of oxygen bubbles, was substantially absent in all the tests. The graphite anode showed a definite softening after 20 hr, which indicated that it would not be suitable; the cast-iron anode showed a relatively uniform pattern of corrosion, with some pitting; and the lead and the stainless steel anodes formed hard coatings which broke off periodically in patches and resulted in a nonuniform type of wear. Both the lead and the stainless steel required several hours of operation in the machine before satisfactory adherence of cake was obtained, although satisfactory cake adherence was obtained from the start with the graphite and cast-iron anodes. Because of the uniform type of corrosion found for cast iron, together with its relatively low cost and structural suitability, this material appeared to be the most satisfactory of those tested. Since practically no evolution of oxygen gas was noted, and in view of the lack of quantitative data on corrosion rate, it was assumed that the corrosion rate would correspond to 100 pct current efficiency; namely, the weight loss of the anode would be represented by the Faraday equation, $W = itK$. Whether this assumption is conservative or optimistic is open to question; a long-term test would be required for reliable data. If the electrochemical equivalent of cast iron is assumed to be the same as that of pure iron, which for present purposes was considered sufficiently accurate, the corrosion rate of cast-iron anodes operated at a current density of 7.4 amp per sq ft would amount to about 0.25 lb of cast iron per ton of tailings dewatered. The cost of anode replacement would enter into the economic balance used to determine optimum current density.

Summary and Conclusions

Phosphate tailing, consisting of a 12.5 pct slurry of minus 10-micron fraction of Tennessee brown phosphate ore, can be dewatered by electrophoresis to 50 to 55 pct water content. A rotating drum type of continuous dewatering machine with a cast-iron anode is suitable for the process.

For best results, the slurry fed to the dewatering machine should contain a maximum percentage of solids commensurate with efficient washing plant operation. The most economical operation is obtained when the solids are removed only to the degree that would permit recycling of the effluent as process water. Sodium metasilicate is preferable to sodium hydroxide as dispersant since the former imparts a lower electrical conductivity to the slurry. The optimum anodic current density depends on an economic balance between power costs and depreciation costs since increase in current densities increases the power requirement per unit of solids dewatered and increases the deposition rate per unit of anode area. For the economic optimum under the conditions of the TVA application, namely, 7.4 amp per sq ft, the power requirement would amount to about 65 kw-hr per ton of solids removed, for which the corresponding deposition rate would be about 8 lb per sq ft per hr.

The study indicated that under present conditions the process is not economically competitive with the use of settling ponds. Electrical dewatering, however, permits recovery of the tailing in a relatively concentrated form potentially suitable for further processing, for example, in the manufacture of fertilizers, or heavy clay products. It is hoped that the process will stimulate the development of uses for this dewatered tailing, which would improve the economics of the process.

Acknowledgments

The authors wish to express their appreciation to A. B. Phillips for design of experimental equipment and to T. P. Hignett for helpful suggestions and advice.

References

1. H. A. Abramson: Electrokinetic Phenomena. (1934) New York. Chemical Catalog Co.
2. Botho von Schwerin. U. S. Patent 1,133,967. March 1915.
3. H. J. Creighton: Electrochemistry. (1943) New York. John Wiley and Sons.
4. C. E. Curtis: *Jnl.* Amer. Ceram. Soc. (1931) 14, 219–263.
5. U. R. Evans: Metallic Corrosion, Passivity, and Protection. (1937) London. Edward Arnold and Co.
6. C. S. Piper: Soil and Plant Analysis. (1944) New York. Interscience Publishing Corp.
7. Sidney Speil and M. R. Thompson: *Trans.* Electrochem. Soc. (1942) 81, 119–145.

Occurrence and Exploration of Barite Deposits at Cartersville, Georgia

By THOMAS L. KESLER,* Member AIME

Introduction

Essentially all of the barite produced in Georgia has come from the Cartersville district in the northwest part of the state. The earliest recorded shipment of ore, 60 tons, was made in 1894.[1] With the exception of the four-year period 1931 to 1934, the separate yearly output has been recorded and published since 1915, whereas the total yearly output of the United States has been published since 1880. The separately recorded production of Georgia (Cartersville) through 1947 is 2,232,544 short tons valued at $14,900,746,[2] but unpublished data on the period 1931 to 1934, plus the estimated unrecorded output prior to 1915, make the actual total about 2,400,000 short tons. This is about 21 pct of the total production of the United States, which, through 1947, is 11,328,440 short tons valued at $71,683,386.[2]

The barite-producing part of the Cartersville district is relatively small, having from north to south a length of 4.5 miles, and a width of 2 miles. This small area, containing 35 barite mines, is the source of practically all of the barite produced in the state. The area is hilly, and has a total relief of 500 ft. The west-flowing Etowah River crosses the middle of the area, and is an unfailing source of water for operations on properties near its course. Opencut mining is carried on during the entire year, but is hampered by rain in the winter and early spring. Three railroads, two U.S. highways, and a network of graded roads provide access to and within the district, as well as excellent shipping facilities for ore and supplies. In addition to the barite, the district contains deposits of manganese, brown iron, ocher, umber, and specular hematite.

Geologic Setting[3]

The area containing the barite deposits is underlain by Lower Cambrian rocks and their weathered residua. These rocks are grouped in three formations; in ascending order, these are the Weisner, the Shady, and the Rome.

The Weisner formation consists mainly of finely micaceous metashale containing many random beds of quartzite, a few beds of conglomerate and metasiltstone, and beds of crystalline limestone that is apparently scarce. The formation is more than 1000 ft thick, and the base is not exposed. On account of their resistance to weathering, the rocks of the Weisner formation have sustained the higher elevations and therefore crop out on the ridges that characterize the area. Nearly all of these ridges are underlain by asymmetric anticlinal folds, and conversely the intervening valleys are underlain by synclinal folds. A diagrammatic section, showing typical mode of exposure of the Weisner rocks and their relation to overlying formations, in the limb of a fold, is shown in Fig 1.

The Shady formation here consists of a lithologically distinctive series of variably siliceous specular hematite beds and thin beds of dolomite, which in places contain abundant fossils. In the zone of weathering, the dolomite has been leached and most of the hematite hydrated to ocherous and umberous clays, but bedding planes in these weathered materials are commonly well preserved with or without distortion effected by slumping. This preservation of structure during weathering is lacking in the residuum that rests on the Rome dolomite, which is described below. The maximum thickness of the

St. Louis Meeting, October 1948. TP 2627 H. Discussion of this paper (2 copies) may be sent to *Transactions* AIME before Nov. 30, 1949. Manuscript received Jan. 12, 1949.

* Geologist, Thompson, Weinman and Co., Cartersville, Ga.

[1] References are at the end of the paper.

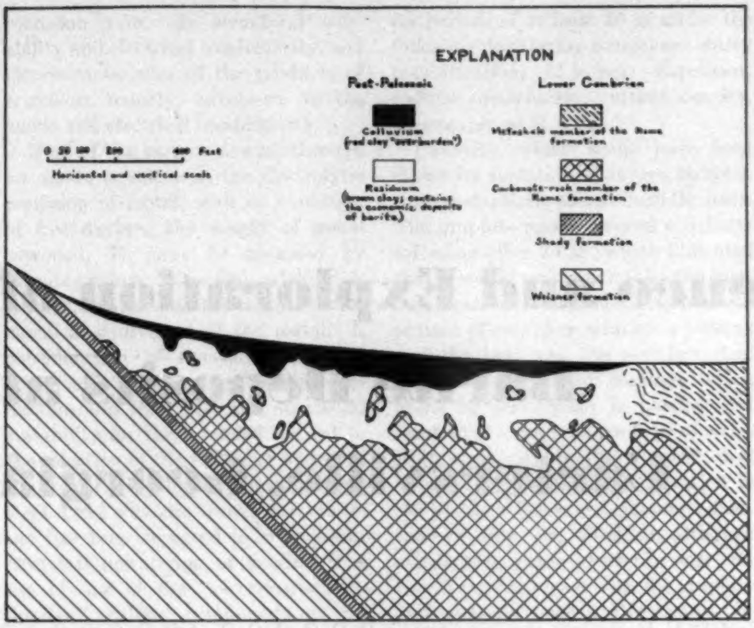


FIG 1—Diagrammatic cross section showing typical association of geologic formations, residuum, and colluvium, and their relation to the land surface. The dip is to the east.

Shady appears to be about 30 ft, and its beds are conformable with, but not everywhere present above, those of the Weisner. The Shady apparently is broadly lenticular, and where it is absent the Weisner is overlain by the Rome formation. The Shady formation has not been recognized previously as here defined, the name having been applied heretofore to the dolomite now included in the Rome formation. For a more complete discussion the reader is referred to the report[3] cited at the beginning of this section.

The Rome formation includes two members, one consisting of crystalline carbonate rocks and the other of metashale. The carbonate-rock member is the more important in the area that contains the barite mines, and there consists largely of dolomite 500 to 1200 ft in stratigraphic thickness. The dolomite is seen only in rare pinnacles and residual boulders exposed in mining ores from a deep mantle of residual clay. This clay is derived in small part from the insoluble constituents of the dolomite, and in large part from constituents of formerly overlying shaly rocks; and all of the constituents have been mixed through long-continued slumping into growing caverns and sinkholes, a process that is still active. Lateral collapse of the Rome metashale into the residual clay is indicated in Fig 1. The clay underlies the slopes of the ridges and parts of the intervening valleys, and is light to dark brown in color. It is known to be more than 100 ft thick in many places, and more than 200 ft thick in a few, and it contains the commercial deposits of barite.

The barite now in the clay was freed from the dolomite by ground-water leaching, and the deposits of economic importance are therefore of residual origin. Originally, the barite and other ore and gangue minerals were deposited in and near faults in the dolomite near the close of folding in late Carboniferous time. At that time, pronounced differences in the lithology of the different formations in the adjacent region caused unequal compression of folds, and therefore unequal shortening. The result was pronounced curvature of the regional strike, in the area now containing the barite deposits, with the development of rotational stress and its consequent pattern of ruptures, as demonstrated in the experiment of Mead.[4]

These ruptures are the faults with which the barite deposits are associated, and they occur in three differently oriented groups. One group trends parallel to the prevailing strike, which, owing to the curvature already mentioned, is N25°E to N25°W. Another group is oriented northwest of the prevailing strike, averaging about N65°W. The third group is oriented northeast of the prevailing strike, averaging about N55°E. Parts of the dolomite, and vein carbonate in the fault zones, were replaced by quartz following the deposition of the ore minerals. The jasperoid thus formed commonly contains brecciated barite, showing that fault movements continued after deposition of the ore minerals.

The major problem involved in the search for new ore is the discovery and tracing of the barite-bearing fault zones. Most of them appear to be steeply inclined, but, owing to the strong effects of slumping and erosion, the direction and amount of displacement are generally obscure. Most of the evidence of these structures must be obtained, and their trends projected, from the ridge crests where beds of the Weisner formation crop out, and are offset and brecciated along the faults. On the slopes, the residual clay that overlies the Rome dolomite is covered by red colluvial clay composed of the coarser materials formerly eroded from rocks that cropped out upslope. Even the gullies, therefore, do not expose the underlying brown residual clay except on the upper slopes where the colluvium is thin. On the lower slopes, the colluvium is commonly 20 to 50 ft thick, and, exceptionally, 100 ft thick where it appears to have filled deep sinkholes.

The Barite Deposits

The residual clay that forms the matrix of the barite ranges in color from yellowish to chocolate brown in contrast with the overlying red colluvial clay. The brown clay is quite tough and dense, averaging about 140 lb per cu ft in place and undisturbed. As its colors suggest, the clay is variably ferruginous. The term residuum is applied to the clay with its content of harder fragmental materials.

The most common of the fragmental materials is jasperoid, which occurs as angular boulders of fine-grained quartz rock stained yellow by ferric hydroxide. Thin sections of the rock show preserved carbonate texture and cleavage, as well as minute residual grains of dolomite enclosed in grains of the quartz. The jasperoid, like the barite, was freed through solution of the dolomite.

The residuum also includes random boulders of quartzite from the Weisner formation, which crops out at higher elevation. These boulders were trapped in early sinkholes, and were mixed with the residual materials by slumping as

the chemical weathering of the dolomite progressed. Similarly, flakes and slabs of partly hydrated specular hematite from the Shady formation have become mixed into the residuum, and are a source of iron contamination in the barite ore.

The residual barite is identical in all respects with barite that is exposed in a few places in uneven veins in the dolomite. It occurs as fragments of irregular shape and size, ranging in maximum dimension from a fraction of an inch to 4 ft, but usually less than 6 in. Each fragment is an aggregate of coarse crystals without crystal faces; the cleavage is pronounced and curved, and the aggregate is snow white to bluish white although thin plates are colorless and transparent. The barite contains very small amounts of quartz and of sulphides that are largely destroyed by weathering. These include pyrite, galena, sphalerite, chalcopyrite, and tennantite, and all of them except pyrite occur so sparsely and in such fine grains that they can be identified only with the microscope. The only product of weathering of the sulphides that is persistent and common enough to be a variably serious impurity of the barite ore is limonite. It occurs attached to the barite and as separate fragments sometimes a foot or more across. Their source is shown by masses of pyrite, only partly weathered to limonite, that have been found in the deeper parts of some of the mines.

The proportion of barite in the residuum is highly uneven. There is no established minimum average grade for profitable operation, owing to considerable differences in accessibility of deposits, amount of necessary dead work, length of haul, and method of concentration. Five mines of moderate to large size previously have shown overall concentration ratios, including both mining and incidental stripping, of 2.9 to 4.6 cu yd of clays in place per long ton of concentrates. These ratios probably no longer can be equalled on a large scale owing to the depletion of ore with shallow overburden. In fact, relatively good bank ore alone, without including material stripped, now shows a concentration ratio of five or more cubic yards per long ton of concentrates.

General Difficulties of Prospecting

Owing to the increasing depth of mining, the circular, hand-dug test shafts so common in earlier years, are

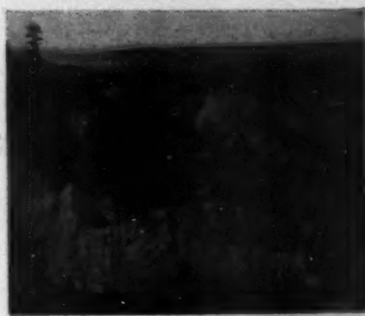


FIG 2—Paga No. 1 barite mine with maximum depth of 150 ft.

no longer sunk in the search for new ore. Few of these exceeded 30 ft in depth, but they were adequate as a guide to mining in areas where the average overburden was thin, as in most of the Paga No. 1 mine shown in Fig 2. This mine which produced about 635,000 long tons of concentrates from 2,250,000 cu yd of residual and colluvial clays, reached a maximum depth of 150 ft. Such depth of ore-bearing residuum is an incentive for deep testing and low-cost stripping in ore-bearing areas with thicker overburden. Deep testing requires mechanical drilling.

Both the colluvial and residual clays as well as the barite may be cut easily with any type of drilling bit, and the walls of drill holes in the clays stand well without casing. These features would permit rapid and inexpensive prospect drilling if the clays were free from boulders of hard jasperoid and quartzite. Owing to the presence of these boulders, it is unusually difficult to obtain satisfactory drill samples of the bank ore to desired depths at systematic, predetermined locations.

Drive-pipe and coring methods, which are commonly used to obtain samples of undisturbed bank ore, are effective only to the random depth at which a hard boulder is encountered. As the clays do not hold the boulders rigidly enough for the use of the diamond or rock bit, such encounters would mean the loss of many holes in any deposit, and of most holes in some, at depths much too shallow. Coring with a plain-end single-tube barrel has given poor recovery because the dense clay and the larger fragments of barite tended to plug the barrel. The end of the barrel was flared even by rotten boulders, and had to be sawed off frequently; hence the use of a plain end. Encounters with these boulders required the use of chopping bits with attendant loss of core.

Power-auger and churn-drill methods, which are commonly used to obtain cuttings representing complete bank ore, involve almost equally serious difficulties. The power auger not only would be stopped by hard boulders, but also would receive a high rate of wear with rapid reduction of gauge. The churn drill probably would penetrate the residuum to any desired depth, but it is doubtful whether its samples would yield sufficient data on the physical properties of the bank ore. The writer has had no opportunity to test this conclusion, but it seems likely that the soft barite would be so finely crushed that the approximate proportions of originally attached impurities could not be determined. It is important, for instance, to know the amount of iron bound to the barite, not the total amount of iron in a sludge in large part consisting of ferruginous clay.

Drilling and Sampling

Complete bank-ore samples, whether cored or bailed, are not essential for estimating ore reserves in clay-matrix deposits such as these. The first product in milling this type of ore is a log-washer concentrate, which includes the barite with attached and unattached impurities on which the balance of the milling is focused. In exploratory drilling in the interest of the Paga Mining Co., the writer obtains, through the action of the drill and supplemental washing, samples fairly equivalent to log-washer concentrates, thus bypassing the difficulty of obtaining proper bank-ore samples. A stage has not been reached yet at which estimates can be checked against subsequent mining yields, and this may require a long period of time. In the meantime, others with similar problems may find the method useful, with improvement or change as conditions may require. The various stages of the process are illustrated in Fig 3 to 6.

A company-owned "seismograph" drill is used which is equipped with a 4 by 5 mud pump and is mounted on a ton-and-a-half truck. It is driven by the truck engine. All barite prospecting is done with N-rods and 3½ in. pilot-type three-wing bits. The pilot bit is superior to other types thus far used in cutting weathered boulders and in maintaining a reasonably straight hole. It will not cut fresh boulders, however, and a few holes accordingly are lost at insufficient depth. Most of the holes range from 50 to 100 ft in depth, and

3

4

5

6

FIG 3—Surface pipe, screen, and spill box used for recovering drill cuttings.
FIG 4—Driller's helpers examine cuttings for barite, and accordingly collect or discard them.
FIG 5—Cuttings containing barite are washed to remove at least part of the clay.
FIG 6—Washed cuttings, mostly barite, from a single drill hole.

the maximum thus far drilled with full water return is 185 ft. Ordinarily, three holes can be drilled and the samples prepared in a 10 hr shift.

Preliminary drilling is commonly done at intervals of about 100 ft, but dumps, pits, and forest growth usually make it impossible to follow a regular grid. In favorable ore-bearing ground, the drill-hole interval is reduced to approximately 33 ft if most of the overburden is thick, or 50 to 70 ft if most of it is thin.

On gentle slopes, water circulation is maintained with a shallow trench from the drill hole to an excavated sump, which is within reach of a 20 ft suction hose on the mud pump. On steeper slopes, where benches for the drill are bulldozed, a steel drum connected with the hole by a wooden trough must be used instead of the sump. Slopes up to 25° have been well prospected in this way.

A 4½ in. bit is used for the upper 3 ft of each hole, in which a surface pipe or short casing is set. The surface pipe, as shown in Fig 3, consists of a 3 ft bottom section and a 1 ft top section of 4 in. pipe, connected by a coupling to which a 4 in. wide steel flange is welded. The flange is driven hard against the soil at the mouth of the drill hole to ensure that all cuttings from the hole will be discharged from the top of the pipe rather than around it.

A 16-mesh rectangular-opening screen (Fig 3) 2 ft wide and 4 ft long, with a hole cut to fit over the top of the surface pipe, is laid over the trench to the sump. The water from the drill hole, with much of the clay in suspension, drains through the screen to the sump via the trench, and the screen retains cuttings of ore, rock, and unsuspended clay.

The overflow from the surface pipe is caught and directed onto the screen by a spill box designed as shown in Fig 3. The box rests on the screen. It has sides 6 in. high cut from sheet metal, and a bottom cut from 16 in. rubber belting, with a hole cut to fit snugly over the surface pipe. The bottom is split from the surface-pipe hole to the mouth of the box, and the metal sides are in two parts that overlap opposite the mouth. These features allow enough flexure for the spill box to be removed whenever desired with the rods in the hole. While the box is in use, the overlap is clamped with a large cotter pin.

During drilling (Fig 4), the cuttings are examined constantly with the use of an ordinary kitchen strainer, and are collected in a steel drum if they contain possibly economic amounts of barite. A single sample is taken from most holes that penetrate ore, and the sample represents the full thickness of the ore. Two samples per hole are taken in rare instances, particularly if unusually good ore in minable thickness is underlain by very lean ore. Two collecting drums are kept ready for such changes in grade.

When the cuttings from an entire ore-bearing interval have been collected, the sump is cleaned out and refilled, and the cuttings are washed vigorously for about 10 min with the use of the bypass hose of the mud pump, as shown in Fig 5. The water pressure is adjusted to prevent any loss of fragmental material, and this possibility is checked by placing a strainer in the overflow from the drum. After being washed, the sample is removed from the drum and weighed wet on a beam scale. An unusually clean washed sample is shown in Fig 6, but most samples contain considerable clay. To avoid the long process of drying in order to convert the wet weight of each sample to dry weight, a standard deduction of 3 lb moisture per gallon of sample is applied to the wet weight. This average has been determined by drying tests on clean, muddy, rich, and lean samples in which the range of moisture content was found to be 2.7 to 3.3 lb per gal. After it is weighed, the sample is cut for chemical analysis.

Most of the barite in the cuttings is plus 16-mesh and minus 1 in. in size. This is far below the size range of an ordinary log-washer concentrate, showing that the barite is considerably broken by the action of the bit. An appreciable amount of the barite, however, is shattered to minus 16-mesh size, and passes through the screen. This fine ore, together with silt, is trapped in a pocket that is dug, near the sump, in the trench leading from the drill hole. This pocket is cleaned out when ore is encountered, and again after passing through the ore, and the silt collected from the ore interval is weighed after settling to eliminate excess water. To reduce analytical work, the amount of barite in the silt samples is estimated on the basis of analyses of silts from typical holes. These show a content of about 40 pct moisture and 14 to 26 pct barite. It appears safe to use an average of 18 pct (30 pct of the dry weight) and to add the amount of barite thus indicated to that shown by analysis of the screened and washed sample. A 24-mesh screen is now being tried in order to retain more of the extremely fine ore cuttings with the washed sample, and preliminary results are favorable.

Estimation of Ore Reserves

Examples of the principal data obtained from the exploratory work and related analyses of samples are condensed in Table 1. The data sheet on an actual deposit, however, might list

50 to 400 holes. Estimating the reserve of barite in a drilled tract, with the use of these data, involves the following steps:

1. From the total number of drill holes, those are selected that appear to show a body of ore that is minable under prevailing conditions. Each drilled deposit is mapped on large scale by plane table, and the surface area of the prospective mining tract is determined from the map by planimeter.

2. The total volume of bank ore is found through use of the surface area and the average vertical thickness of ore shown by the drill holes selected. The tract may be treated as a single unit if the drill-hole interval is approximately uniform, but must be broken into two or more parts if the interval varies. The volume of overburden is similarly found, and the cost of its removal is finally compared with the estimated value of the concentrate reserve.

3. The cubic yardage removed in drilling the bank-ore footage in each hole is determined, using a hole diameter 1 in. greater than the diameter of the bit. Inspection of many holes shows that this allowance may be excessive, and it may be reduced when more definite information is at hand.

4. The long-ton weight of $BaSO_4$ recovered from the bank ore penetrated in each hole is determined. This value is derived from the dry weight of the washed sample and its chemical analysis, plus an allowance for the fine ore in the silt. The proportion of Fe is determined only where its amount may be of concern in milling.

5. The optimum concentration ratio for the bank ore in each hole is found by dividing the cubic yardage of bank ore removed by the tonnage of $BaSO_4$ recovered from that volume of bank ore. This value, being based on volume rather than weight, is dependable and may be applied easily to measurements made from time to time during mining. Grade of bank ore in percentage of $BaSO_4$ by weight is less dependable, as the unit weight of the clay is not uniform and the average content of boulders cannot be determined. The curve shown in Fig 7 gives the equivalent values within narrow limits, however, and is based on an average weight of 140 lb per cu ft of barren clay in place, undried and undisturbed.

6. The average concentration ratio is obtained by weighting the concentration ratio of each hole according to the footage of bank ore penetrated in that hole, and dividing the sum of the weighted values by the total footage of bank ore penetrated in all of the holes.

7. The apparent reserve of pure barite in the tract or part thereof is obtained by dividing the total volume of bank ore found in step 2 by the average concentration ratio found in step 6. The amount may be corrected according to the anticipated grade of concentrates, but this correction is not large enough to affect the economic outlook of a deposit.

If the procedure outlined above indicates a reserve that is not in good proportion to the cost of the necessary stripping and mining, the area of the prospective tract is reduced or enlarged by eliminating or including marginal drill holes, and the apparent reserve in the adjusted area is then computed. It may be necessary to repeat this procedure several times before the most favorable mining tract is evident, and it is believed that the reserve as thus determined will not differ substantially from the actual yield.

Table 1 . . . Example of Data Used in Estimating Reserves of Barite [a]

Hole No.	Elevation	Bank Ore						$BaSO_4$ Recovered		
		From	To	Penetration	Cu Yd Removed	OCR[b]	Ratio Weighted[c]	From Washed Sample, Lb	From Silt, Lb	Total (Long Ton)
1	824.0	13	70	57	0.2337	4.49	255.93	101.8	15.0	0.0521
2	834.5	16	68	52	0.2132	3.81	198.12	110.4	15.0	0.0560
3	827.2	16	60	44	0.1496	11.51	506.44	23.1	6.0	0.0130
4	829.0	18	56	38	0.1387	6.48	246.24	39.9	8.0	0.0214
				191			1206.73			

$$\text{Average concentration ratio} = \frac{1206.73}{191} = 6.3$$

$$\text{Apparent reserve of barite in long tons} = \frac{\text{total cu yd bank ore}}{6.3}$$

[a] Condensed from form ordinarily used.
[b] Optimum concentration ratio (cubic yards of bank ore in place per long ton of barite).
[c] Product of "OCR" and "Penetration."

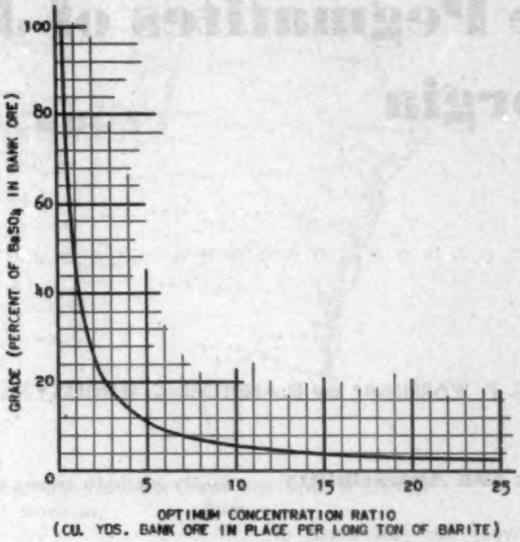


FIG 7—Curve showing relation of optimum concentration ratio to grade of barite bank ore at Cartersville.

References

1. E. W. Parker: Barytes. Mineral Resources of the United States, 1894. U.S. Geol. Survey. 16th *Ann. Rept.* (1895) (4) 701.
2. U.S. Geol. Survey and U.S. Bur. Mines. Mineral Resources of the United States, and Minerals Yearbook, 1880 to 1946. Also, U.S. Bur. Mines, MMS-1645 (1948) 3.
3. Thomas L. Kesler: Summarized from Geology and Mineral Deposits of the Cartersville District, Georgia. U.S. Geol. Survey. Report in process of publication.
4. W. J. Mead: Notes on the Mechanics of Geologic Structures: *Jnl. Geol.* (1920) 28, 518–523.

The Pegmatites of Jasper County, Georgia

By LENDALL P. WARRINER* and BLANDFORD C. BURGESS,* Members AIME

Location and Accessibility

Jasper County lies just north of the geographical center of Georgia, bounded on the west and north by the Ocmulgee River. The county seat, Monticello, is approximately 65 miles east-southeast of Atlanta and 40 miles north of Macon. It is served by the Macon-Athens branch of the Central of Georgia Railway Co. and by five paved highways converging from adjoining county seats. Farming and lumbering are the principal local occupations.

About half the county is covered with pine and mixed hardwoods; a large part of the forested land is owned by the Soil Conservation Service of the Department of Agriculture in its Piedmont Land Utilization Project. The topography is one of gently rolling field and forest with occasional hills rising 100 ft or more above the creek beds. Though annual rainfall is in the neighborhood of 60 in., most of it falls in torrential downpours of short duration which tend rapidly to erode the red soil and convert the country roads to greasy tracks of red mud.

History

The pegmatites of Jasper County produced a small amount of mica in World War I. In World War II, our Government's search for this strategic mineral brought to Georgia B. C. Burgess, then Southern Manager of Colonial Mica Corp., subdivision of Metals Reserve Corp., who noted on State Highway 83 the presence of pegmatitic material used as road metal.

In 1944, after severing his Government connection and returning to private practice, Mr. Burgess investigated the source of the pegmatitic material noted on his previous visit and discovered that graphic granite pegmatite had been mined for the road metal. He secured mineral leases from the Soil Conservation Service and from private owners and began preliminary development work. By 1946 he had uncovered enough pegmatite to warrant an enterprise to undertake economic development of the feldspar. In March 1947, he conveyed his leases and interest to Appalachian Minerals Co., remaining with it as Vice President and General Manager.

This company has carried on additional development, removing overburden by bulldozer and drilling the pegmatites uncovered. A modern and efficient feldspar grinding plant to produce 20 mesh feldspar for the glass industry was completed and placed in operation May 1, 1948.

St. Louis Meeting, October 1948.
TP 2620 H. Discussion of this paper (2 copies) may be sent to *Transactions* AIME before Nov. 30, 1949. Manuscript received Oct. 19, 1948.
* President, and Vice President and General Manager, respectively, Appalachian Minerals Co., Monticello, Ga.

Geology

GENERAL GEOLOGY OF ROCK TYPES OTHER THAN PEGMATITE

Jasper County lies within the Appalachian Crystalline Complex and approximately 40 miles north of the "Fall Line," where the Upper Cretace-

FIG 1—County map of Georgia showing location of Jasper County with respect to geologic provinces.

ous sediments of the Coastal Plain lap against the gneisses* of the Piedmont (Fig 1).

The southern half of the county is underlain by hornblende gneiss of igneous origin. Its composition approximates 50 pct hornblende in granular crystals and 50 pct plagioclase, with very minor biotite, garnet, magnetite, and chlorite, the last from decomposition of the hornblende. Originally it was probably a diorite. Within Jasper County only this rock is known to play host to the pegmatites.

The northern section of the county is underlain by augen gneiss, with a small northeasterly-striking tongue of granite gneiss cutting the augen gneiss in the northwest corner. Mica-bearing pegmatites have been located and worked in the augen gneiss in Monroe County, adjoining Jasper to the west and south.

A small granite plug intrudes the granite gneiss near the tip of the tongue, and another, used by Jasper County as a source of crushed stone for its roads, is intrusive into hornblende gneiss in the southeast corner of the county.

A number of doleritic dikes strike approximately N15°W, crosscutting all the major rock types including the pegmatites. A narrow dolerite dike cuts pegmatite at the Heard mine without causing either displacement or alteration, although fracturing in the feldspar along the boundaries appears to be oriented parallel to the strike direction of the dolerite. The dolerite itself weathers in blocky fragments which on exposure tend to spall and form round boulders locally termed "niggerheads."

The gneisses are deeply weathered and decomposed to as much as 40 ft in places with the soil zone seldom thicker than 4 ft. The granite and dolerite are much less weathered, the surface zone displaying a foot or two of soil, followed by broken fragments with oxidation extending downward along joints and fractures for only a few feet. Fig 2 shows the geology of Jasper and surrounding counties.

GEOLOGY AND MINERALOGY OF THE PEGMATITES

Mineralogy

The mineralogy of the Jasper County pegmatites is simpler than that of most deposits of this type. Rare minerals have not been noted, and minerals other than the feldspar, quartz, and mica are limited almost entirely to the iron minerals; garnet, magnetite, and ilmenite in that order of abundance.

Microcline occurs most frequently, with some albite in close association. Pink microcline and white albite in 1 in. crystals, interspersed with gray translucent quartz, show up beauti-

* Geologic map of Georgia, 1939.

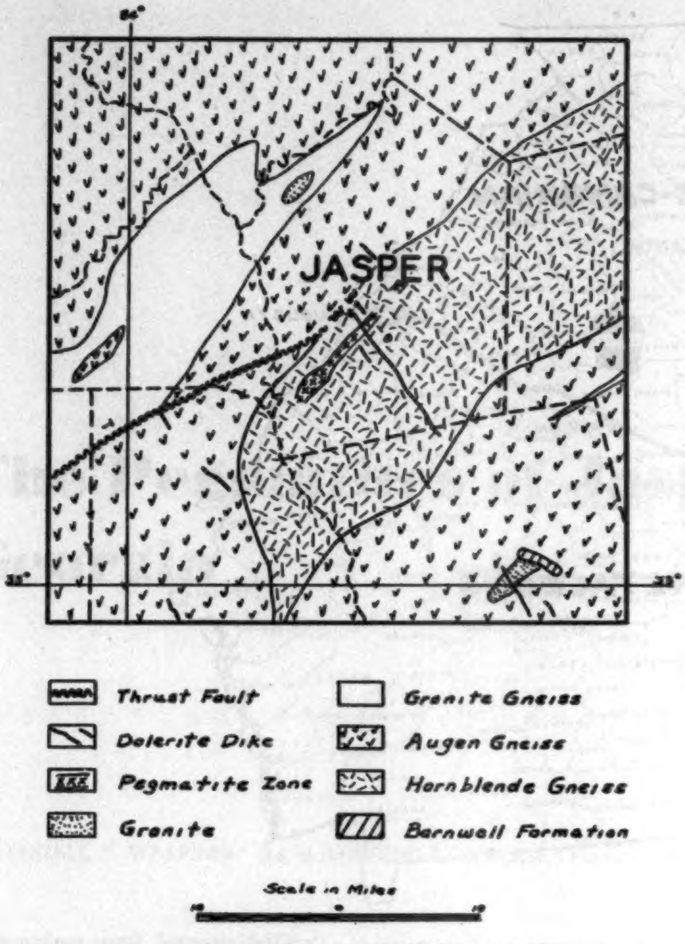


FIG 2—Geology of Jasper and surrounding counties.

fully in the freshly blasted face of the Comer No. 2 mine. In general, however, the microcline in crystals and masses up to 2 ft or more across obscures the occurrence of albite, particularly near the surface where the microcline has been bleached to a creamy white color. Below outcrop, the microcline is a delicate flesh pink, with many specimens showing a pink core fading outward to white. One occurrence of light green amazonite has been located; it too fades on exposure to sunlight.

Quartz, the second most abundant mineral, forms occasional, prominent "cores" in the pegmatites. Although none of these cores has been fully exposed yet, there are massive segregations in lenticular form up to 100 ft in length by 40 ft in width. This quartz is generally white and of a sugary texture. Elsewhere the quartz occurs in stringers and veinlets in the mass of pegmatite or along the walls. For the most part, however, it is present as grains or irregular masses in the pegmatite.

Mica appears as muscovite and vermiculite. The largest book so far located weighed 34 lb, but unfortunately displayed severe "ruling." Mining has not yet progressed far enough below the weathered zone to uncover solid block mica, but some salable pattern and punch mica is recovered from the feldspar mining operations. The muscovite generally runs in small books about 2 by 3 in. with rounded outlines. Smaller crystals display near-perfect hexagonal prisms. In color, the muscovite varies from pale greenish-white to a very dark green, but the very pale variety is limited to the vicinity of the amazonite feldspar. It forms aggregates with quartz, generally where crystallization of the pegmatite appears to have been interrupted by chilling. A feature of its occurrence with a fairly uniformly-sized ground mass of quartz and feldspar is long thin streaks radiating like a sunburst from a common center and extending outward for as much as 6 ft. This type of structure carries some vermiculite, which, in the graphic granites, occurs in identical structure. Both the muscovite and vermiculite occurring in this fashion are highly fractured and tend to break in small pieces. Partial crystals, half muscovite-half vermiculite, show a vermiculite core extending shallowly into the muscovite. Dana* states that biotite "is not infrequently associated in parallel position with muscovite, the latter, for example, forming the outer portions of plates having a nucleus of biotite." The vermiculite, then, reasonably can be attributed to the alteration of biotite. It is most abundant in the graphic granites, in plates up to 8 in. in length and 5 in. across. Outside of the pegmatites proper, it has been developed as fine flakes in the gneiss along the pegmatite borders and where small inclusions of gneiss lie wholly within the pegmatite. It may be the result of weathering.

The minor minerals, spessartite and almandite garnet, magnetite, and ilmenite, seem to be distributed heterogeneously, although the last two have been noted only in the graphic granites. The spessartite garnet has been found in dodecahedrons up to 5 in. in diameter, but so badly fractured and weathered as to be irrecoverable. Garnetiferous bands a couple of inches wide extend from the gneiss contact into the segregated pegmatite at the Heard mine for 20 ft or more, the garnet being of pinhead size. A limonitic stain penetrates the pegmatite for 1 or 2 in. around exposed garnets or magnetite, and a thin film of hematite coats the fractured surfaces of the magnetite. Magnetite is fairly abundant in the graphic granite as small grains, but poorly formed crystals up to 2 in. are to be found. Ilmenite, far less common, attains comparable size.

Texture

As in all pegmatites, the texture is highly irregular, varying from a micropegmatite at the chilled edges to coarse segregation generally near the center of the major dikes. Segregated masses or "ribs" of microcline in some cases

* E. S. Dana: Descriptive Mineralogy. New York. John Wiley and Sons.

parallel the strike and dip of the pegmatites, and in others have dips and strikes bearing no relation to the attitude of the enclosing dike. Were the "ribs" to form the basis for a successful mining operation, a careful study of the structural control might be warranted, but no attempt is made to mine selectively at present. Fig 3 shows the microcline feldspar, quartz and graphic granite at the Benton property.

Chilled edges are general in these pegmatites, the minerals of the border zone being mixed too thoroughly to make hand sorting possible. The presence of a quartz core, however, almost invariably indicates large crystals of feldspar and of muscovite in association.

Although each pegmatite exhibits some form of zoning, no generalization can be made for the group as a whole. However, there appears to be a regional zoning in that from southwest to northeast the segregated pegmatites give place to graphic granites.

Origin

A more detailed regional study than we have been able to make will be necessary before valid conclusions may be drawn for the origin of these pegmatites. Their distribution indicates injection along a line of structural weakness parallel to the regional strike of the gneisses in which they occur, although local disturbance of the schistosity has taken place. Genetically and in time they are probably related to the biotite granite and granite porphyry batholith responsible for the prominent topographical feature, Stone Mountain. Continued exploration in Jasper County may uncover pegmatite in conjunction with the granite and thus afford the opportunity to study their relationship in detail.

Prospecting and Development

Residual quartz, derived from pegmatites and veins, is widespread throughout Jasper and adjoining counties. Older quartz, however, has acquired a patina of limonitic stain that distinguishes it at once from quartz weathered out comparatively recently. Fresh sugary white to gray translucent quartz generally indicates the presence of a nearby pegmatite. Heavy boulders as a rule are in place and mark the quartz "ribs" of a well-segregated pegmatite. Generally fragments of blocky microcline feldspar may be noted in the surrounding soil.

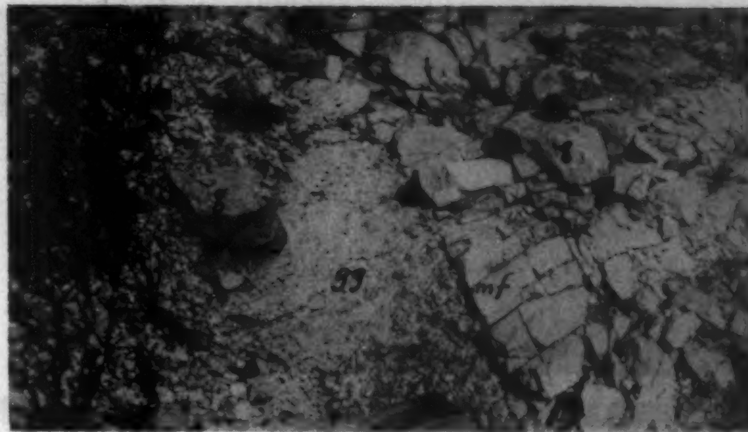


FIG 3—Microcline feldspar (mf) and quartz (q) in conjunction with graphic granite (gg), Benton property.

Since the pegmatites decompose less rapidly than the enclosing gneisses, they usually stand out as substantial hillocks and almost invariably outcrop on higher ground. Feldspar and graphic granite "float" mark these elevations and hillsides. It is interesting to note in this connection that nearly every pegmatite so far located was once covered by a plowed field. Although these fields have been abandoned for more than 25 years and now support a crop of 8 to 10 in. slash pine, the terraces and furrows are still visible. The former growers of cotton (the boll weevil wiped out the county's cotton in the years 1920 to 1921) may have discovered, probably by chance, that the soils derived from the weathering of high-potash microcline produced more cotton per acre.

Prospecting methods are simple. When the presence of float indicates a pegmatite, a base line as nearly as possible conforming to the long axis of the body is run out. Transverse lines are spaced at 50 ft intervals and are picketed out at right angles to the base line well beyond the estimated boundaries of the body. Soil auger holes of 4 in. diam are bored on these lines at measured intervals, with the hole locations and identity of the cuttings plotted on a base map. The soil and gravel from the pegmatites is virtually impenetrable while the decomposed gneiss is penetrated easily. The outlines of the body, and occasionally even the direction of dip, can be quite accurately determined by this method.

Removing overburden and loose outcrop material by bulldozer is the second stage if the soil auger work indicates a sizable pegmatite. As little as possible of the loose pegmatite is pushed off, as this material yields a high recovery of feldspar when washed and screened.

Detailed geological mapping follows, accompanied by shot drilling to determine the attitude and thickness of the deposit. The broken and blocky nature of the ground makes diamond drilling prohibitively expensive, with core recovery hardly better than 10 pct. Shot drilling, on the other hand, makes up for its lack of speed by eliminating time lost in fishing for lost core and in other headaches attendant upon diamond drilling in broken ground. Furthermore, because the information sought is not so much the tenor of the pegmatite as its dimensions, the high cost of diamond drilling is not justified by the information to be obtained. For example, contract prices for EX holes ranged from $2.50 to $3.50 per foot, with overburden on a cost plus basis. The company, using an antiquated Sullivan Bravo machine and with inexperienced runners drilled 13 holes ranging in depth from 22 to 69 ft at an average cost of $1.20 per foot. No. 6 and No. 7 chilled shot made satisfactory progress through material that destroyed diamond bits in as little as 10 ft.

By these methods, it is estimated that in excess of 750,000 tons of pegmatite have been proven. Probable and possible reserves are several times that amount.

FIG 4—Feldspar grinding plant of Appalachian Minerals Co. from the northeast.

Table 1 . . . Analyses of Samples of Graphic Granite and Quartz-free Samples of Feldspar

Sample No.	6	9	10	11	12
Mine	Gladesville	B. C.	Heard	Bowden	Comer
SiO_2	73.80	64.50	66.20	65.20	64.77
Al_2O_3	14.94	20.33	19.35	19.63	19.71
Fe_2O_3	0.06	0.07	0.05	0.07	0.06
CaO	0.20	0.20	0.30	0.30	1.57
MgO					0.33
K_2O	9.18	13.06	12.07	12.21	10.10
Na_2O	1.86	1.57	1.82	2.13	3.10
Loss	0.15	0.26	0.16	0.24	0.20
Total	100.19	99.99	99,95	99.78	99.84

Mining

The conventional hand method of working segregated pegmatites by sinking a shaft or open cut on feldspar-rich streaks has been discarded in favor of handling mine run pegmatite rock in a central washing and sorting plant. In this fashion, recovery of feldspar in the finer sizes is greatly increased at low cost.

Drilling and blasting practice varies with the individual deposit, but in general when a quarry face is established 8 to 10 ft holes are drilled by jackhammer on 4 to 6 ft centers and 5 to 7 ft burden. These holes are loaded with about one-half pound per foot of 30 pct extra gelatin dynamite and blasted simultaneously with No. 9 electric caps fired by a 20-hole battery. This loading tends to lift the area drilled, leaving it thoroughly broken yet with minimum fragmentation. The broken ground can then be scraped without difficulty caused by oversize lumps or solid ribs.

A long narrow cut two benches (18 to 20 ft) deep is advanced from 150 to 200 ft from the scraper set-up before side benching begins. Alternate cuts the full length of each side provide steady scraping without interfering with drilling.

Because electric power is not available at the mines, double drum Jaeger Model 2A3 hoists are used, powered by Allis Chalmers 25 hp internal combustion engines using tractor fuel. The mining method makes it unnecessary to change the position of the tail block more than once a shift, consequently the double drum hoists are adequate to do the job and represent less capital outlay with more economical operation. These hoists haul a company-designed, partial-box hoe type scraper with a 54 in. face, capacity approximately ½ ton, up a 20° steel-rail-faced ramp, depositing the broken ore on a grizzly of 56 lb rail on 10 in. centers over a 15 ton capacity wooden bin. The broken ore is trucked to the head of a central washing plant located on another pegmatite. Here production can be made from trucked material or from the pegmatite rock mined at the plant site.

At the washing plant, an Austin Western 24 in. belt conveyor raises the broken ore to a 32 in. diam by 9 ft long trommel screen with 1½ in. round openings, where it is scrubbed and washed. Trommel oversize passes to a sorting table mounted over an Austin Western 3 compartment 20 cu yd capacity steel bin. The washed feldspar is forked into the outer compartments by two men, who also remove block mica to burlap sacks mounted under funnel-shaped wooden frames on the bin deck. A feature of the sorting table is its hinged construction which permits accumulated waste to be dumped into the inner bin.

A dust jacket with ½ by 2 in. slotted openings removes fines from the minus 1½ in. from the trommel. The minus 1½ plus ½ in. is discharged from the jacket to a sorting table. Mica and quartz are removed by hand. Undersize from the dust jacket is flushed down a tail race by the wash water. The cleaned feldspar passes to the nearer of two 5-ton capacity wooden bins, the waste quartz being placed in the other.

Mixed loads of plus 1½ and plus ½ in. are trucked to the grinding plant (Fig 4) at the railroad, weighed on Fairbanks-Morse scales, and dumped into one of four 250 ton covered storage bins.

Products and Uses

Samples of graphic granite and selected, practically quartz-free samples of feldspar from some of the deposits have been analyzed with the result shown in Table 1.

The products of the sorting plant from the two mines operated by this method and from two other mines where ordinary hand sorting is practiced have given commercial feldspars of the analyses shown in Table 2.

Table 2 . . . Analyses of Commercial Feldspars

Sample No.	26	37	38	47
SiO_2	71.80	69.50	68.00	69.30
Al_2O_3	16.53	17.51	18.43	17.63
Fe_2O_3	0.07	0.09	0.07	0.07
CaO	0.20	0.20	0.10	0.10
MgO	0.04	0.04	0.04	0.04
K_2O	9.45	10.44	11.80	11.30
Na_2O	1.84	2.28	1.57	1.50
Loss	0.10	0.14	0.14	0.14
Total	100.03	100.20	100.15	100.08

The present grinding plant is limited to the preparation of feldspar for glass manufacturers.